

# CONTRACTS IN NORWEGIAN TUNNELLING

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NORWEGIAN TUNNELLING SOCIETY

PUBLICATION NO. 21



# NORWEGIAN TUNNELLING SOCIETY



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**CONTRACTS IN  
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HELLI - Visuell kommunikasjon AS

post@helli.no

www.helli.no

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## FOREWORD

The publication “Contracts in Norwegian Tunnelling” is part of the English language series published by the Norwegian Tunnelling Society NFF.

The aim is to share with colleagues internationally information on aspects of underground work. The publications are mainly focusing on technical issues. This time however, the publication concentrates on contracts and contract related issues.

The publication starts with an introduction to the Norwegian contract regime followed by papers relevant for this topic with contributions by important parties in a project implementation stage. Also included are examples of partnering and target price contracts as well as observations from three sub sea tunnelling projects.

Contract disagreements are well known for contract partners in underground construction. Most matters are solved through discussions and internal negotiations between the contract parties, for some contracts however, this avenue is difficult. Organised mediation during project implementation is a method to be considered for selected projects. The technique is reviewed.

During the final stage of the project we have received special assistance and support from the NFF Secretary Thor Skjeggedal and member of the international committee Aslak Ravlo.

Sincere thanks to authors, contributors and supporters.

May 2012

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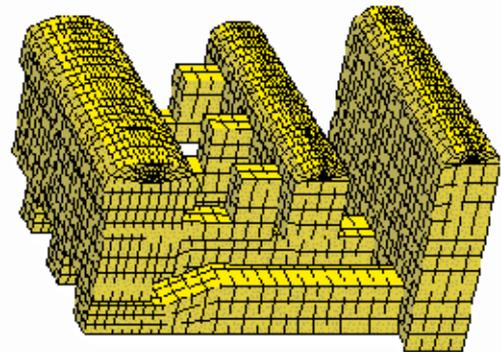
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## INTRODUCTION

### RAVLO, Aslak

#### HISTORY

Organized underground work in Norway dates back some three hundred years starting with the mining of minerals. Contracts were few, unbalanced and served the authorities.

The first railway -line in Norway, 64 km northbound from Oslo to Eidsvold, was opened for traffic in 1854. The project was privately initiated, funded by investors while civil works were executed by a foreign contractor based on an agreement that today might be called a turn-key contract. The two tunnels in the project were regarded as minor obstacles.

In 1890 the Norwegian Parliament decided that purchase of supplies and work paid for by the government should be based on tendering. Governmental agencies and municipalities immediately started to prepare their own tendering procedures. The first set of standard contract documents, however, was prepared by the Norwegian Polytechnic Society, also in 1890. National standards are younger. The Norwegian Standards Association, dates back to 1923; today Standards Norway which is a private organization, has the sole right to issue Norwegian Standards [NS].

The market segments roads and railways were always dominated by governmental organizations using internal resources for construction, maintenance and operation. Several decades into the 20th century national infrastructure projects were still implemented by governmental agencies without tendering, without contracts, based on budget allocations, eventually compensated "at cost". The hydropower sector was and is organized differently. Up to 1911 this sector was more or less unregulated. New legislation in 1911 and 1917 gave municipalities, inter-municipality ventures and the government special privileges. Municipalities and private industry implemented their projects through contractors subsequent to tendering whereas the government used own resources.

In spite of the general situation, one will find exceptions.

"Bergensbanen", the 500km-long railway line between Oslo and Bergen that was opened for traffic in 1909, included 182 tunnels in hard rock. Most of the work was executed by the national railway authorities, but some parts were handled by contractors. The most impressive contract concerns the 5311-metre-long Gravhalsen tunnel. Adverse climatic conditions, limited information of the geology, no risk sharing or price escalation provisions are factors most contractors would avoid, then and today. A brave contractor accepted the harsh terms and signed a fixed price contract. The contractor met his obligations, gained experience and lost money.

#### THE LEGAL SITUATION TODAY

When discussing contract practice for underground construction in Norway some basic information may be useful. Norway's relations with Europe are regulated through agreements for the European Economic Area. Most laws and regulations affecting contracts, tendering procedures and non-discrimination provisions are the same as those within the European Union. Euro Codes are generally adopted. National Standards in Europe are to some extent harmonized.

For contracts where public entities are involved, procedures for tendering, procurement and the entering of contracts are also governed by the Norwegian Public Procurement Act with additional provisions and addenda. Governmental agencies have been reorganized with focus on laws, regulations, overall planning and representing the government as owner.

In the hydropower sector, it is the Norwegian Water Resources and Energy Directorate (NVE) that handles regulations, concessions and more whereas the Norwegian energy company Statkraft is owner and operator of some 40% of the installed capacity in Norway.

- The Norwegian Public Roads Administration is responsible for the planning, construction and operation of the road network. Most of the work, however, is based on tendering and contracts with enterprises in the market.
- The Norwegian National Rail Administration is responsible for the management of the national railway network based on tendering and contracts.

**THE MARKET**

The major part of underground work is tunnelling for highways, railways, hydropower development and underground openings related to onshore facilities for oil and gas development. Other projects could be caverns for public use including water and sewage services or private sector activities. Since 1971 NFF has presented annual statistics on tunnelling. Market shares for the various segments vary from year to year. Details will be seen from the below chart.

The majority of underground construction activities today are thus dominated by the owners mentioned above plus several municipal ventures. The oil industry is an on/off participant. Major contractors for tunnelling number eight to ten companies .

Due to the political system governmental projects depend on annual budget allocations decided by the Parliament resulting in numerous small and medium-sized projects. The observations from three build-operate-financed road contracts during the last ten years and also challenges within the rail segment indicate that the established system ought to be changed.

**TECHNOLOGY, CONTRACT PROVISIONS AND DISAGREEMENTS**

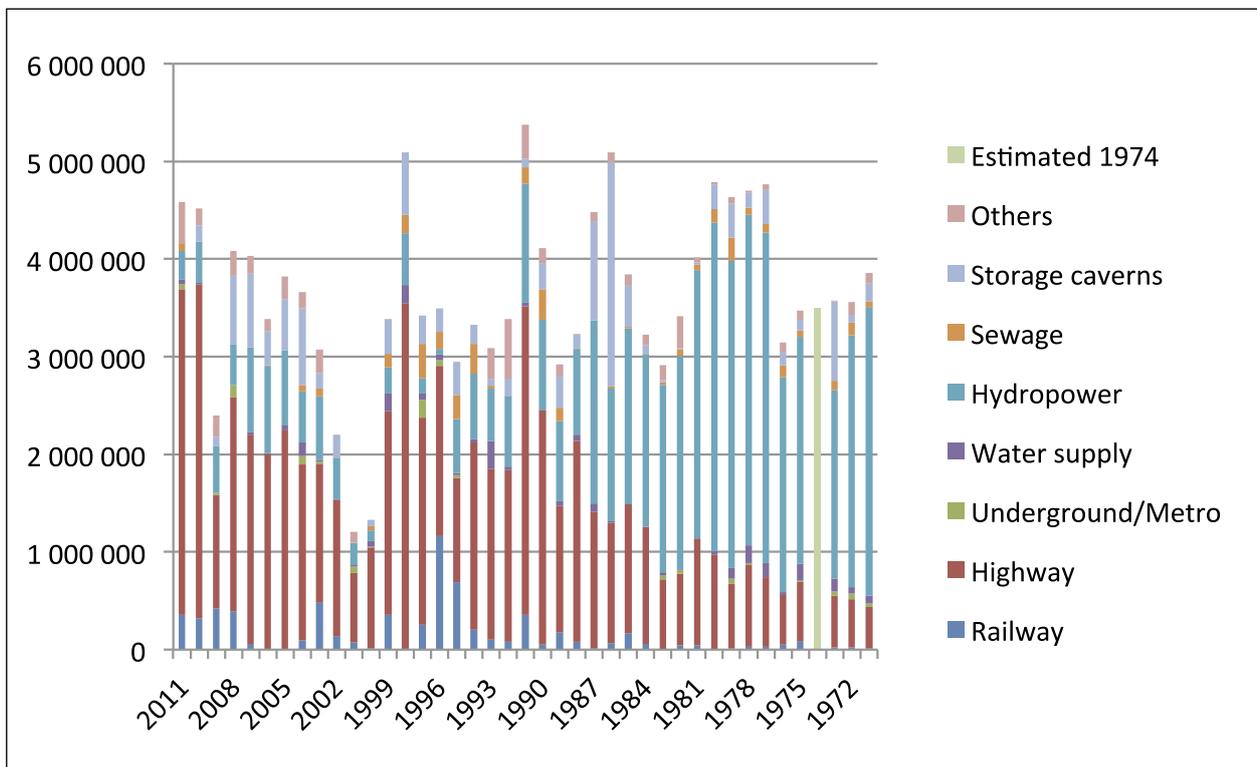
The development of underground construction technology in Norway is closely related to hydropower. It

started around 1900. Surface power stations and steel penstocks were typical features. This situation changed from say 1947-1950.

The new tunneling tools, like high quality drilling equipment, new loaders and trucks, rock mechanics expertise and rock supporting methods, increased tunnelling capacities and reduced costs. The most hectic hydropower development period ever in the country coinciding with the general post-war demand for reconstruction put strain on the available resources requiring new and cost efficient solutions.

Basic contract terms were: Owner-supplied plans and quantities, unit price system, National Standards, fair payment terms, regular project meetings with competent representatives from the contract parties with powers to conclude matters at site.

Pre-investigation of geology and rock mechanic parameters were limited. Inevitably, one would sometimes meet unexpected situations at tunnel face causing delays or reduced progress, requiring additional rock support, concreting or handling of water ingress beyond expectations. With a view to finding a balanced approach to solving such problems, major owners and the industry agreed on special terms for compensation, timewise and moneywise. It was accepted by the parties involved that contracts based on risk sharing principles would



improve quality and reduce costs. Several of the papers will deal with these provisions which we believe are unique.

Norway is a mountainous country with a rugged coastline and many outlying islands. Numerous communities with few people are still waiting for safe road connections. Modestly constructed roads and tunnels will still be needed. In the cities commuter systems to bring people in and out of the centre effectively are needed, calling for tunnels and underground usage. A new era of hydroelectric power development will see further application of underground solutions. The traditional contracts with the unit price system, flexible quantities and a fair risk sharing profile will be needed also in the future.

Disagreements beyond friendly negotiations cannot be avoided. Hydropower companies used to include a clause on arbitration, whereas the governmental agencies are bound to litigation.

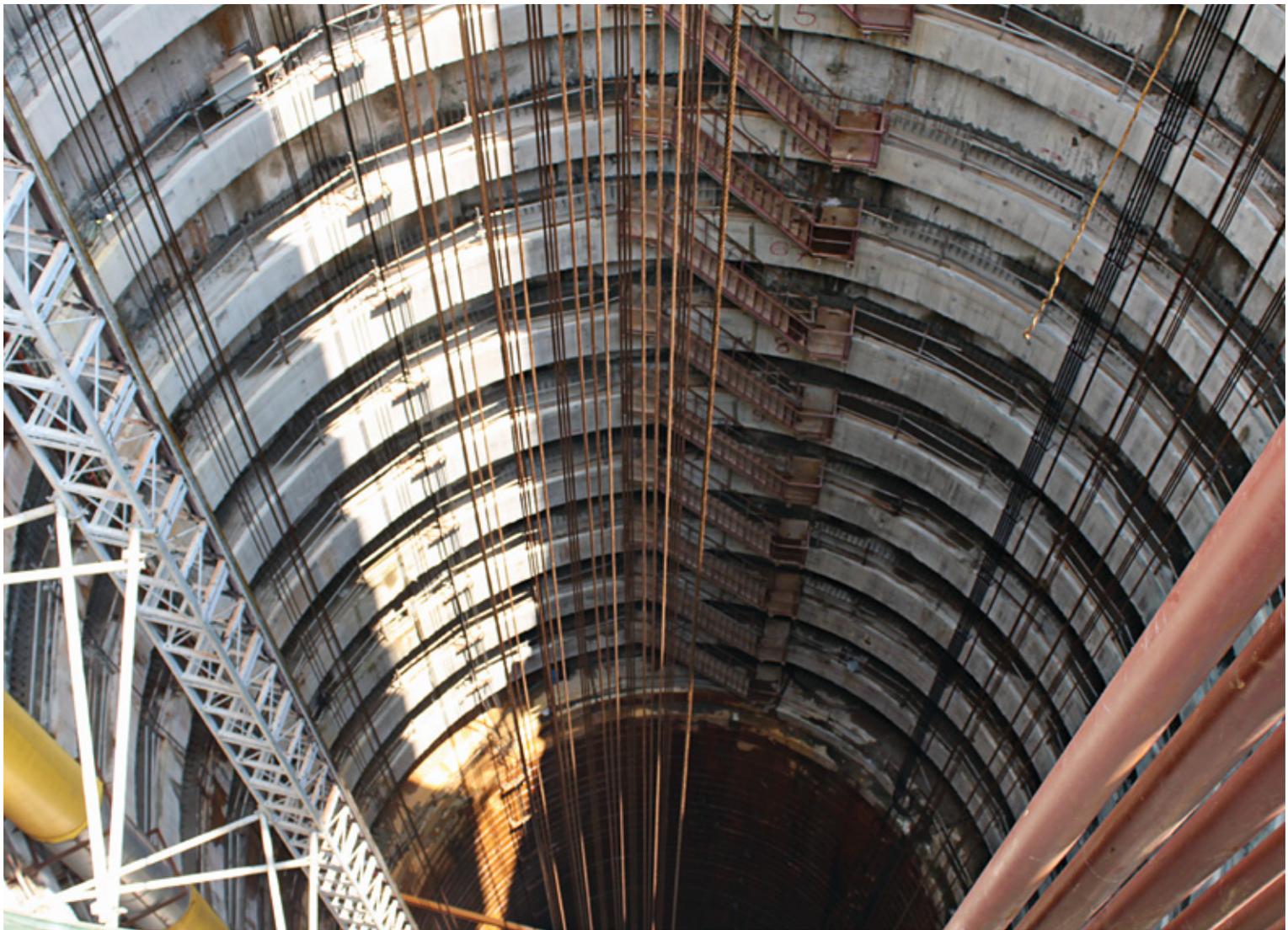
Organised mediation as a means of solving contract problems during the construction period have been used internationally for decades. During recent years this approach has also been utilised in Norway. All systems include stronger and weaker aspects. In the end, cooperation between the contract partners based on competence and reason seems to be the advisable avenue to take.

### THE FUTURE

The handing over of a completed project to operation means the start of a new phase where maintenance costs and depreciation must be covered. The construction standard and the quality of the technical installations in a lifetime perspective are in such respect of paramount importance. Some thoughts on the development of contracts for underground projects as well as advice to future owners and developers are included.



*The Contract is signed. Order to commence is submitted. Photo: Hilde Marie Braaten, National Rail Administration.*



*Jurong Caverns, Singapore*

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- Industrial waste disposals and Industrial freezing storage
- Crushing plants

## 02. CONTRACT PHILOSOPHY IN NORWEGIAN TUNNELLING

GRØV, Eivind

The tunnelling concept regards the rock mass as being a construction material. Consequently the pre-construction assessments of the rock quality form important input for estimating quantities of the cost items included in the BoQ. These assessments are also forming the basis for the prediction of the construction time. Quantities, also for options, must represent realistic estimates to receive well considered prices and schedules. During the construction phase it is important that both the client and the contractor have competent people at site to determine the support measures needed and to assess the rock mass conditions at and ahead of the tunnel face. [1] This latter being especially relevant for the execution of the grouting works.

The contract parties in underground construction may have different objectives in some matters. However, in a broader perspective there are probably more common interests at the construction site than interest of conflicts. Cooperation is important, including aspects such as; respect for the different roles and values, experienced professionals participating in the decision making, conflicts being solved at the construction site.

Planning for the construction implies that contingency and precaution need to be included in the contract to handle expected or unexpected conditions. The Norwegian unit price contracts place the risk for varying ground conditions on the owner. The contract does normally not include different prices for excavation depending on rock quality encountered, separate unit prices are however included for such measures as reducing the blasting length to half the normal, or dividing the tunnel face into various sections. [2]

Before contracting, the ground conditions are mapped and a geological report is compiled which later becomes part of the contract documents. This report is not a geological base line report. The geological report describes what have been recorded in terms of factual data and in addition a part that presents a description of the expected ground conditions, that is an interpretation of the factual data. This gives the owner a basis for assess-

ments on measures and quantities to be specified in the contracts. It also provides the contractor an information basis for his own judgement of the ground conditions that he may use for calculations and planning purposes. Predictability is a key issue and it is important that information is provided from one phase of the project to the next and that nothing is getting lost in the process.

In the bill of quantities, the owner is specifying various support methods and stipulates the quantities, trying as accurately as possible to stipulate the amounts that he expects will be carried out, as this gives the least surprises, and the truest picture of the scope of work. The contractor is paid according to the actual amounts carried out. [3]

### RISK SHARING

By far, most underground projects in Norway during the last 50 years have been contracted as unit price contracts. During the hydropower boom in the 1960's through the 1980's, a contract concept was developed and applied that focused on risk sharing. The risk sharing contracts address two main elements of risk:

- Ground conditions. The owner is responsible for the ground conditions. He 'provides the ground', and is also responsible for the result of the site investigations he finds necessary to do. If these prove to be insufficient, it shall remain his problem.
- Performance. The contractor is responsible for the efficient execution of the works. He shall execute the works according to the technical specifications. He is reimbursed according to tendered unit prices for the work actually completed. The construction time frame is adjusted based on preset 'standard capacities' ('time equivalents') for the different work activities, if the balance (increases minus decreases) of the work changes.

By this, the owner keeps the risk of increased cost if the ground conditions prove to be worse than expected; after all he has chosen the site location. He will also earn

the savings if the conditions are better than expected. The contractor keeps the risk of his own performance. If he is less efficient than the norm set by the ‘standard capacities’, he may fall behind schedule and will have to catch up on his own expense to avoid penalties. If he is more efficient, he may finish earlier, saving money by this and increasing his profit, besides what he is hopefully earning within his unit prices.

The risk sharing principles ideally eliminates most discussions about ‘changed conditions’. It becomes a matter of surveying the quantities performed, and the payment and construction time adjustment follow accordingly. This works well as long as the variations in ground conditions can be dealt with by just applying more or less of the work activities regulated by the tendered unit prices and the preset ‘standard capacities’. This however assumes that all necessary work activities are included, which may not be the case if an unexpected and unforeseeable geological feature occurs. This system, its development and application was described by Kleivan (Ref. 11) who coined the term NoTCoS – the Norwegian Tunnelling Contract System. In Figure 5 it is illustrated how this risk allocation produces the lowest cost possible in average for a number of projects.

**CHARACTERISTICS OF UNIT PRICE CONTRACTS**

The typical unit price contract in Norway is characterised by the following:

- Geological/geotechnical report. This report is prepared for the owner based on the performed site investigations. It shall give a full disclosure of the information available. Traditionally it also contained interpretations, not being limited to factual data, but this practise has unfortunately been compromised by some of the larger public owners. It is a pre-requisite

that all important geological features have been identified. The tenderers shall anyway establish their own interpretation.

- Bill of Quantity (BoQ). The quantities for all work activities, such as excavation, rock support, grouting, lining etc, as well as installations, are included in quantities according to the best expectations by the owner assisted by his advisors. Preferably, the owner shall refrain from tactical inflation of the quantities in order to get lower unit prices. Tactical pricing from the tenderers may occur, but can be discovered by analysis of the bids.
- Variations in quantities. The actual quantities may vary due to variations in the ground conditions. The contractor is reimbursed as per actual performed quantity and his tendered unit prices. The unit price shall remain fixed within a preset range of variation, for some contracts this may be set as +/- 100%.
- ‘Standard capacities’ (‘time equivalents’). Traditionally these have been set by negotiations between the contractors’ and owners’ organisations. They may be updated concurrently with technology developments, but are usually kept from contract to contract over a period of a few years. As long as they are reasonably realistic, they provide a fair tool for adjusting the construction time and completion date if the balance of ‘time equivalents’ increases more than a specified amount.

For this system to work properly, some conditions are important:

- Experienced owners and contractors. The parties must be experienced with underground works and the site management teams from both sides must have the nec-

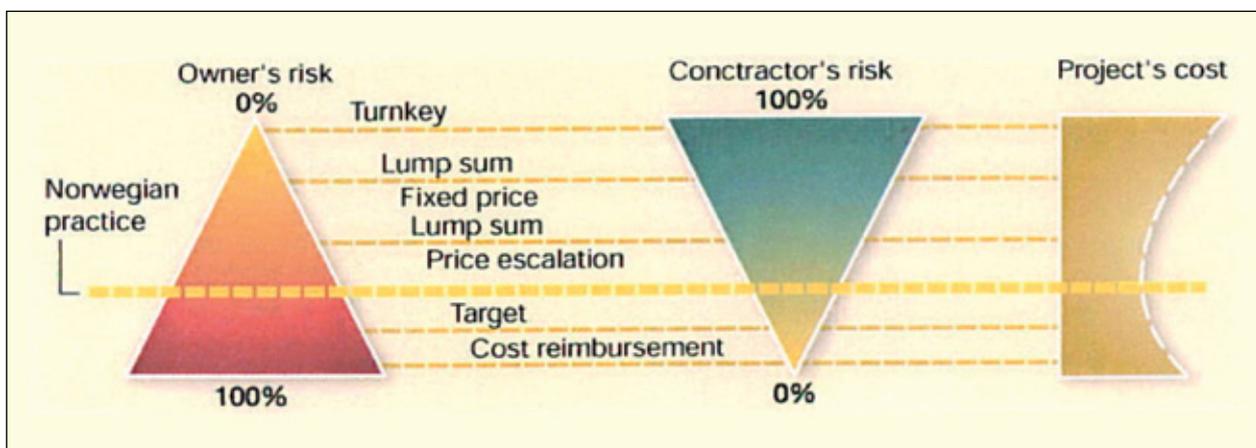


Fig. 5: Risk allocation principles (Kleivan, Ref. 11)



Photo: Svein Skeide, Public Roads Administration.

essary authority to take decisions, allowing technical and contractual issues to be solved at site as they occur. This requires respect for each other and their tasks.

- Decision making. Of critical importance is the ability and authority of the representatives of both parties to take decisions at the tunnel face, especially with respect to primary rock support and ground treatment as pre-grouting etc.
- Acquaintance with the contract. If both parties are acquainted with the principles and details of the contract, discussions and agreements can be made expediently and with confidence as need arises. This is typically the situation when both parties are experienced from a number of similar projects.

A main advantage with this system is that the contractor's incentive to meet the penalty deadline will be maintained, even if ground conditions get worse. Contractors have recently voiced as a disadvantage that their role is limited to performing the specified work for the owner without incentives to introduce innovative solutions by which the contractor could better utilise his special skills. Some owners do not ask for, or even allow, alternative solutions to be introduced. However, this is not due to the type of contract, but to how it is applied.

### **CONTRACT CLAUSES TO TACKLE VARYING QUANTITIES AND CONSTRUCTION TIME FOR EXPLORATORY DRILLING AND SUPPORT MEASURES**

As a part of Norwegian tunnelling important decisions are taken at the tunnel face, both related to the need for measures ahead of the tunnel face and support at the face. A possible consequence is that a considerable difference might occur between the stipulated quantities in the contract and the actual quantities as carried out.

To tackle this, the contract has defined "the 100 % rule" in the specification describing support [3]:

- The unit prices apply even if the sum of actual quantities differs from the bill of quantities by up to  $\pm 100\%$ .
- If the owner or the contractor wishes unit prices to be adjusted, prices are set by negotiation.
- The adjusted unit prices shall not differ from the contract's unit prices by more than 20 %. Adjusted price shall be determined according to documented expenses.

These regulations take care of differing quantities that might occur due to changes in the geological condi-

tions, but not the fact that varying quantities also have an impact on the contractor's available time towards the date of completion. To handle also the aspect of construction time a contract clause has been introduced that is called "the equivalent time principle" for adjusting the total construction time depending on the actually applied support methods [2]. This is particularly related to tunnelling operations that are needed to secure a safe tunnelling but are hampering the tunnel advance:

- If the actual quantities for tunnel support vary in comparison with the contract's estimated quantities, the completion time is adjusted according to predefined standard capacities for the different operations, for example:

– Manual scaling	1 hour/hour
– Bolts up to 5 m	12 bolts/hr
– Sprayed concrete (shotcrete)	6 m <sup>3</sup> /hr
– Concrete lining	0,1 m/hr
– Exploratory drilling and pregrouting	60 m/hr

- The total time for support measures is summed up in hours, both performed and described amounts from the bill of quantities.
- The difference (between accumulated values) is calculated
- The contractor normally has a tolerance for added support measures (typically a week per year of construction time)
- When this tolerance level is exceeded, the exceeded time value is calculated as shifts and days, which are added to the completion time.

These standard capacities resulted from negotiations between the contractor's organisations and representatives from the owners. The standard capacities reflect the state-of-the-art in Norway, based on equipment and methods being standard at a given point in time, and may not unconditionally be transferred to other countries. However, the equivalent time principle has proved to be a useful tool for sharing the risk for both owner and contractor.

In combination these two clauses are useful tools to remove some uncertainty regarding risk in tunnelling contracts, meaning that the risk that the contractor has to bear is considered as fair. The owner must always bear in mind that risk has a price. In order to reduce the total construction sum, we must try to reduce the contractor's risk as well. No matter the type of contract chosen for

a project, if the contractor is forced out of the contract, by termination, bankruptcy or something similar the ultimate risk taker would be the owner.

In figure 1 below a classical risk principle is shown. In the long run it shows that the Norwegian contract practice based on unit rate contracts would in average produce the lowest construction cost.

## COURT CASES

Despite the advantages and good track record of the typical unit price contracts in Norway, some projects end with disagreements and eventually in court. This appears often to be due to:

- Inexperienced owners. The owner may be lacking experience with underground projects. Deviations from the expectations may put him 'off his feet' and the co-operation with the contractor deteriorates into contractual confrontations, instead of solving the problems as they arise.
- Insufficient funding for contingencies. The project may be based on too optimistic cost estimates. This could be by purpose to get approval from the authorities or by sheer lack of respect for the potential variations of nature.
- Public scrutiny. Public projects may be subject to criticism for any decision made during construction that deviates from the expected. The project management may prefer to stick to the letter of the contract in order not to be criticised, and allow disagreements to accumulate and be dealt with in court.
- Tougher profit requirements. The contractors, in order to survive in an increasingly competitive climate, focus on the economical result of their contracts. If a contract does not bring the planned profit by just performing the contracted work, it may be tempting to seek additional compensation in court.

## SETTLEMENT OF DISPUTES

During the recent years basically all Norwegian contracts contain a clause stating that disputes that are not resolved by the contract parties at the project site, are raised to a dispute resolution forum on a higher level. This forum includes representatives from the company management of both the owner and the contractor. The representatives from both owner and contractor may agree to invite experts who may advise a solution. [2]

There is currently a drive in the tunnelling industry in Norway towards obtaining again solutions at the con-

struction site to avoid disputes being brought to arbitration and court. Such solutions may involve technical as well as commercial and contractual aspects. For some large projects, for instance the Bjørvika immersed tunnel in Oslo, dispute review boards were appointed. Feedback so far suggests that the DRB's are playing an important role in resolving disputes. An additional effect is that the DRB's mere existence seems to have increased the willingness to reach a solution at the site meetings. If the dispute is not resolved by any of the chosen means, the ultimate solution still remains to forward the case to the court.

### REQUIREMENTS TO THE CONTRACT

The authors believe that a suitable balance for risk allocation can be found, allowing a combination of the advantages of both unit price and fixed price contracts. It follows that the risk allocation must be specified in the tender documents, to the level of describing the geological features or the stabilisation and ground treatment methods that are included in the contractor's risk. Not to forget: the contractor must be able to price the risks allocated to him. In developing such contracts, it may be useful to define success criteria for the project along these lines:

**Cost:** The aim is to get the total cost as low as possible, including both the price for realistic tenders and the

risks that remain with the owner. Predictability of total cost may come at a price.

**Compliance:** The owner has to set the quality standards considering the life-time costs. Durable solutions are not for free. This also relates to other aspects such as compliance to

**Completion:** Both parties have a strong economic interest to keep the completion date. The timely completion is probably the success factor that is most easily monitored by the public. The construction time can still be adjusted according to preset regulations.

**Confidence:** The confidence in the outcome of a project is imperative for financing institutions and for the public as well, who in many cases are the users. This includes safety during and after construction towards hazards such as collapse, water flooding, and loss of the tunnel or of lives. In modern safety regulations the owner has an overall responsibility for safety, whereas the contractor maintains the executive responsibility.

**Control:** The contractor needs to control (in the sense of ensuring) his performance. If this is done according to modern quality management principles, the owner may rest 'assured'. The owner may still want to survey the performance of the works, both with respect to quantity (progress) and quality.



*Photo: Svein Skeide, Public Roads Administration.*

## CONCLUSIONS

In order to achieve success according to these criteria, the following requirements to the contract may apply:

- Incentives. By including incentives for the contractor, not only penalties, it is possible to stimulate focus on productivity, while maintaining quality and safety. Experience shows that in standard unit price contracts it may be tempting for the contractor to increase his production volume by applying more rock support than strictly necessary, especially if particular support measures are tactically priced. If he instead gets a bonus for early completion, and possibly also a compensation for saved rock support ('lost production'), this may turn around. The owner will then have to follow-up to ensure the sufficiency of the rock support for permanent use. The maintenance of safety during construction under such circumstances may be challenging, and requires experienced personnel for follow-up.
- Conflict solving. It is important to keep, or get back to, the problem solving at site instead of in the courtrooms. A tool to achieve this may be the use of advisory 'reference groups'. A key point is that such groups meet on a regular and frequent basis to monitor the works, before small problems develop into conflicts. In this respect a 'reference group' may have a different function than 'dispute resolution boards' dealing with already materialised disagreements. The responsibility of such 'reference groups' should be defined in the contract. The personnel should be nominated by the parties and include professionals with practical tunnelling experience.
- Co-operation. Although it is frequently expressed in contracts that the parties have a duty to co-operate, as is the case with Norwegian contracts, this may not always come easy. It may be effective to stimulate this by focusing on the strong common interest in completion on time. However, other tools may also be used, e.g. 'geotechnical teams' to which co-ordination of geotechnical issues can be referred and disagreements about e.g. choice of rock support measures can be solved.
- Functional requirements. The use of functional requirements, rather than detailed technical specifications and work instructions, may stimulate innovation and development by the contractor. However, functional requirements are not easy to apply for rock works, and the result of many of the work processes does not lend itself to quality checking afterwards (e.g. grouted rock bolts).
- Regulations for 'changed conditions'. As the inclusion of all uncertainties in a fixed price may result in a very high price, it may be beneficial overall to be specific about the risk allocation. A suitable balance may be found by identifying which features shall be included in the fixed price and which are kept as a risk of the owner, to be reimbursed by specified regulations. To include risk sharing clauses would be in agreement with the recommendations by the International Tunnelling Association(Ref. 13).

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## 03. NORWEGIAN STANDARD NS 3420 IN CONTRACTS FOR UNDERGROUND WORKS

LUND, Morten

### INTRODUCTION

The Norwegian Standard NS 3420 is standardized technical specifications for civil engineering works in a coded system based on a unit price system for use in tender documents. The standard can also be used to systemize and cost estimate components and partially works, calculation and quality control and supervision during construction. Contracts with technical specifications based on NS 3420 are mainly Employer managed unit price contracts with NS 8405 as the contractual standard. Contracts for underground rock works are mainly of this category.

NS 3420 forms the foundation for quantity bearing items in tender documents to be calculated by the Contractors. The items are encoded according to a system that defines the scope and content of the items. The code defines requirements for materials, execution, tolerances, testing and control for each item. It also gives rules for measurement and payment. The standard is organized with a hierarchical structure where requirements on a higher level are valid for lower levels. It has a superior part, part 1, named General conditions, that contains requirements valid for all the technical parts of the standard.

NS 3420 is a Norwegian Standard consisting of 25 parts where 5 of them are so called common or general parts and the others are divided into technical subjects. Parts relevant for underground works are the following:

- Part 1 - General conditions - with requirements valid for all other parts;
- Part A - Preliminaries and General Provisions - contains items for insurance, planning, establishing, management and rigging down the site including re-establishing the area after completed contract;
- Part F - Earthworks - part 1 - contains items such as blasting, uploading, transportation and rock support etc.;

- Part G - Earthworks - part 2 - contains items for more complicated geotechnical and engineering geological works such as drilling of micro tunnels in rock and soil, TBM-drilling, rock- and soil anchors and grouting etc.;
- Part L - Concrete works - contains items for cast in place concrete rock support and sprayed concrete;

The use of NS 3420 is based on the principal that the Employer designs what he wants and the Contractor decides how to construct it as specified. The risk for ground conditions is normally placed with the Employer in this type of contracts. The Employer normally hires a consultant to do the design. NS 3420 has standardized requirements to help the Employer to achieve an acceptable level of quality with possibilities to specify to a higher level of quality if wanted. This way it is possible to adapt to the Employers specific needs for each project.

### PRELIMINARIES AND GENERAL PROVISIONS

Preliminaries and General Provisions including Contractor's camp facilities can be specified in different ways depending on how much interference the Employer wants to have in the process.

- Basically the Contractor is obligated to take into account all he need to fulfil his contract in a legal matter. If the Employer do not have any special requirements or no wish to interfere , when it comes to preliminaries and General Provisions, the bill of quantity can consist of as few as 3 - 5 items covering this part of the contract.
- Further it is different ways for the Employer to specify certain requirements for items of his interest without complicating the simple principal of few items for calculation.
- At last it is a set of detailed items for a complete specification of an Employer controlled work site. Mainly

these items are meant for one Contractor that are partly or completely establishing and managing a work site for another contract than his own. Though in some cases the Employer wants to keep detailed cost control of certain element of the work site, and it will be suitable to use these detailed items to highlight the cost.

General conditions, NS 3420, part 1

The overall general requirements in NS 3420, part 1 - General conditions relevant for underground rock works, are mainly the following:

- the completed item, a component or partially work, is to be mounted or executed, connected, tested for function, calibrated and ready for use;
- the prices are to include supply of material, use of accessory materials, salary, social expenses, tools and machinery, scaffolding, mobile cranes and lifts in addition to administration and profit;
- materials chosen by the Contractor is to be adapted to the base, required mounting, adjacent constructions and requirements for the finished product. The materials shall in addition be durable or adaptable to the anticipated climate, strain or wear during use.
- the materials shall be undamaged and without errors, they shall be transported handled and stored in such a way that the finished product is not deteriorated.
- the Contractor shall hold the competence and equipment needed to fulfil the contract.
- products shall fulfil the required function, when it comes to conditions concerning use, environmental and maintenance;
- technical solutions or execution methods chosen by the Contractor, shall be according to the required function or output and they shall be feasible and durable to the anticipated climate, strain or wear during use.
- mounting is to be done according to producers/suppliers descriptions.

We will look further into some items and how they are specified. The list is far from complete.

### TUNNEL BLASTING, CODE FHI.4

Classification of the perimeter for blasting is defined in table F5 in part F like this:

Perimeter class	Requirements
0	There is allowed no rock to protrude inside the designed perimeter
1	Some rock is allowed to protrude maximum 0,15 m inside the designed perimeter
2	Some rock is allowed to protrude maximum 0,5 m inside the designed perimeter
3	No requirements for the perimeter

Table F5 - Perimeter classification

#### Note 1

The following perimeter classes are common for different constructions:

- Perimeter class 0 for hydropower-, road- and railway tunnels;
- Perimeter class 1 for some rock cuts and -pits above ground;
- Perimeter class 2 for road cuts, cuts later to be back-filled and some cuts and pits under water;
- Perimeter class 3 for temporary cuts for example in quarries and some cuts and pits under water;

#### Note 2

A perimeter class can be achieved by use of various measures like reduced drill hole spacing, moving the theoretical collaring line further away from the designed perimeter or by hydraulic hammering of rock protruding inside the acceptable perimeter.

Tunnel blasting is specified under code FH1.43 with two alternatives of payment, according to volume of rock or length of tunnel. An item for tunnel blasting can look like this:

#### **FH1.432111**

#### **BLASTING OF TUNNEL – LENGTH**

TUNNEL CROSS SECTION: FULL CROSS SECTION

ROUND LENGTH: NORMAL ROUND LENGTH

PERIMETER REQUIREMENTS: PERIMETER CLASS 0

Location: Access tunnel to power station

Restrictions: Vibration requirements are given in Appendix 5, section 2.

Tunnel cross section: 30 m<sup>2</sup>.

Other requirements: No

Length m 750

The code FH1.432111 defines basically what the item includes. In addition to the overall requirements given in Part 1 - General Conditions (see above) the requirements apply from the following levels (“chapters” in NS 3420); F, FH, FH1, FH1.4.

The 5 last digits are the results of specifications given directly in the item setup above (explained in the order they appear); 3 means tunnel, 2 means payment according to length, 1 means the choice FULL CROSS SECTION (in one round), 1 means the choice NORMAL ROUND LENGTH, and the last 1 means PERIMETER CLASS 0.

Requirements valid for the tunnel blasting from the different levels of the code structure will be:

- Level F - Earthworks - part 1 gives no requirements.
- Level FH - Rock excavation requires that rock excavation is to be executed in such a way that unnecessary weakening of the final perimeter shall be avoided and the perimeter shall be as even as possible.
- Level FH1 - Excavation by blasting requires:
  - the price includes necessary drilling, charging, drill- and charging trouble and required perimeter blasting;
  - the perimeter holes, and normally also the holes in the next row shall be charged with reduced charging adjusted to the hole spacing and rock conditions;
  - solid rock is not allowed above designed invert;
  - collaring of a drill hole is not allowed inside designed perimeter and deviation of single holes shall not be larger than 100 mm from the Contractors planned collaring.
- Level FH1.4 - Underground excavation by blasting requires:
  - the price includes handling of water with up to 500 l/min. per face, and scaling at face with 1 hour per round plus weekly or periodically scaling with up to 5 hours per week;
  - drill holes in the perimeter shall have a spacing of 0,7 m and a burden to the next row of 0,9 m which is to be drilled parallel to the perimeter and not have a hole spacing exceeding 2 x the spacing in the perimeter.
  - the perimeter holes shall be charged with maximum 1,12 MJ/m in the column charge, anfo is not allowed;
  - for tunnel blasting it is required a deviation in direction at the collaring point of maximum 6 %;
  - there shall be separate items for safety measurements (FH1.1), uploading (FM1.2), transportation (FM2.2), water handling exceeding the included limits, that is 500 l/min per face (FJ1) and tunnel intersections (FH1.4811).

**UPLOADING AND TRANSPORTATION, CODE FM**

The quantity of uploading and transportation is regulated for geological caused overbreak.

- Overbreak caused by inaccurate drilling or careless blasting is not paid for.
- Overbreak caused by reasons outside the Contractors control is measured according to table F9 for underground works.

Type of work	Measurement rules
Underground blasting, see figure F12	Overbreak less than 0,5 m outside designed perimeter are not measured. Geological caused overbreak protruding 0,5 m outside designed perimeter (see shaded area in figure F12) is profiled and calculated into the quantities of uploading and transportation.

Extract of table F9 - Measurement of overbreak

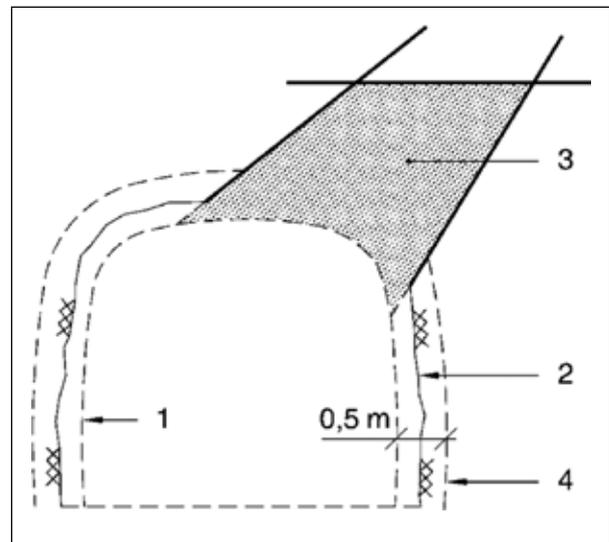


Figure F12 - Principle of volume of overbreak for underground blasting

Legend

- 1 Designed perimeter
- 2 Executed perimeter
- 3 Geological caused overbreak
- 4 Line 0,5 m from designed perimeter

Items for uploading and transportation may look like this:

#### **FM1.2314**

##### **UPLOADING – SOLID VOLUME**

PLACE OF UPLOADING: PLACE OF UNDERGROUND BLASTING

Location: Access tunnel to power station

Type of masses: Debris from blasting

Other requirements: No

Designed solid volume m<sup>3</sup> 22500

#### **FM2.21314**

##### **TRANSPORTATION WITHIN THE WORK SITE – SOLID VOLUME**

##### **TO PERMANENT DUMP OR TEMPORARY STORAGE**

UPLOADING PLACE: PLACE OF UNDERGROUND BLASTING

PLACE OF UPLOADING: PLACE OF UNDERGROUND BLASTING

Location: Access tunnel to power station

Type of masses: Rubble from blasting

Dump site: Dump site by the power station

Other requirements: No

Designed solid volume m<sup>3</sup> 20000

#### **FM2.223145**

##### **TRANSPORTATION OUT OF THE WORK SITE AREA**

UPLOADING PLACE: PLACE OF UNDERGROUND BLASTING

TOTAL LENGTH OF TRANSPORTATION: FROM 4 UNTIL AND INCLUDING 6 km

Location: Access tunnel to power station

Place of delivery: Dumping in Valley A at the Hillbilly farm

Type of masses: Rubble from blasting

Other requirements: No

Designed solid volume m<sup>3</sup> 2500

#### **Rock support, code FP1**

**Extra scaling** - The price for the blasting operation includes a minimum of basic scaling. Scaling exceeding this limit will be paid only when accepted or ordered by the Employer in advance.

**Rock bolting** - The following types of rock bolts are the most common rock bolts in Norway and possible to choose directly from the standard:

- mechanically end-anchored rock bolts;
- resin end-anchored rock bolts;
- fully grouted rock bolts;
- combination bolts.

In addition it is possible to choose

- self drilling rock bolts;
- friction bolts;
- fibre glass bolts.

Installation of rock bolts includes material, drilling and flushing of the drill hole, specified dished anchor plate, semi-spherical washer and nut, necessary pre tensioning, post tensioning to obtain the function as temporary support and specified testing as seen below.

e1) Rock bolts shall be tested in the following amount separately for each bolt type in use:

- At least 50 % of the first 100 rock bolts shall be tested. If more than 5 % of the tested bolts fail, 50 % of the next 100 bolts shall be tested. This system shall continue until less than 5 % of the tested bolts fail.
- Further 25 bolts of each 1000 installed bolts shall be tested with the same accept criteria as above. If the accept criteria is exceeded, the test procedure shall go back to testing 50 % of each 100 bolts until the criteria again is obtained.
- If pull test is used it shall be pulled up to 10 % above work- or design load.

#### **Concrete works, code L**

Concrete works are mainly specified with codes from part L.

**Cast in place concrete rock support** - A set of items may look like this including preparation works:

#### **LB5.511**

##### **MOBILIZATION OF PREFABRICATED FORMWORK**

Location: Outside Power station

Tunnel cross section: 30 m<sup>2</sup>

Other requirements:

a) Scope and price basis

Time needed for mobilisation to be given in Appendix X.

Lump sum LS

#### **LB5.523**

##### **RIGGING OF PREFABRICATED FORMWORK IN TUNNEL**

WORK PLACE: BEHIND FACE

Location: Headrace tunnel

Tunnel cross section: 30 m<sup>2</sup>

Other requirements: No

Number of times no 4

**LB5.5332****USE OF PREFABRICATED FORMWORK IN TUNNEL**

WORK PLACE: BEHIND FACE  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Tunnel cross section: 30 m<sup>2</sup>  
 Other requirements: No  
 Length m 20

**LB8.22402****END CLOSING OF FORMWORK – AREA**  
TYPE OF CONSTRUCTION: WALLS AND ROOF ARCH

SURFACE: CONTRACTOR'S CHOICE  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Dimension: Contractor's choice  
 Other requirements: No  
 Area m<sup>2</sup> 8

**LB8.31****ADJUSTING FORMWORK TO ROCK SURFACE**

Location: Headrace tunnel  
 Other requirements: No  
 Length m 15

**LC1.1152****REINFORCEMENT WITH REBAR**

REINFORCEMENT CLASS: B500NA  
 DIAMETER: 16 mm  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Other requirements: No  
 Mass kg 2000

**LG1.3123343220****CAST IN PLACE ROCK SUPPORT – LENGTH**

WORK PLACE: BEHIND FACE  
 TYPE OF CONSTRUCTION: WALLS AND ROOF ARCH  
 COMPRESSIVE STRENGTH CLASS: B35  
 DURABILITY CLASS: M45  
 CLORID CLASS: Cl 0,40  
 INSPECTION: EXECUTION CLASS 2  
 CURING MEASUREMENTS: CONTRACTOR'S CHOICE  
 ACCORDONG TO NS-EN 13670+NA  
 Location: Headrace tunnel  
 Tunnel cross section after casting: 28 m<sup>2</sup>  
 Other requirements: No  
 Length m 20

**LG1.318334322****EXTRA CONCRETE FOR CAST IN PLACE ROCK SUPPORT**

WORK PLACE: BEHIND FACE  
 TYPE OF CONSTRUCTION: WALLS AND ROOF ARCH  
 COMPRESSIVE STRENGTH CLASS: B35  
 DURABILITY CLASS: M45  
 CHLORIDE CONTENT CLASS: Cl 0,40  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Other requirements: No  
 Volume m<sup>3</sup> 10

**Shotcrete** - A set of items may look like this:

**LJ2.111****RIGGING FOR SHOTCRETING FOR ROCK SUPPORT**

Location: Headrace tunnel  
 Other requirements: No  
 Number of times no 20

**LJ2.122232122****SHOTCRETE FOR ROCK SUPPORT**

WORK PLACE: AT FACE  
 COMPRESSIVE STRENGTH CLASS: B35  
 DURABILITY CLASS: M45  
 CHLORIDE CONTENT CLASS: Cl 0,40  
 FIBRE REINFORCEMENT: ENERGI ABSORPTION CLASS E700  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Other requirements: No  
 Volume m<sup>3</sup> 150

**LJ2.122232132****SHOTCRETE FOR ROCK SUPPORT**

WORK PLACE: AT FACE  
 COMPRESSIVE STRENGTH CLASS: B35  
 DURABILITY CLASS: M45  
 CHLORIDE CONTENT CLASS: Cl 0,40  
 FIBRE REINFORCEMENT: ENERGI ABSORPTION CLASS E1000  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Other requirements: No  
 Volume m<sup>3</sup> 50

**LJ2.123233882****SHOTCRETE FOR ROCK SUPPORT**

WORK PLACE: BEHIND FACE  
 COMPRESSIVE STRENGTH CLASS: B35  
 DURABILITY CLASS: M45  
 CHLORIDE CONTENT CLASS: Cl 0,40  
 FIBRE REINFORCEMENT: WITHOUT FIBRE  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Other requirements: No  
 Volume m3 50

**LJ2.123232122****SHOTCRETE FOR ROCK SUPPORT**

WORK PLACE: BEHIND FACE  
 COMPRESSIVE STRENGTH CLASS: B35  
 DURABILITY CLASS: M45  
 CHLORIDE CONTENT CLASS: Cl 0,40  
 FIBRE REINFORCEMENT: ENERGI ABSORPTION  
 CLASS E700  
 INSPECTION: EXECUTION CLASS 2  
 Location: Headrace tunnel  
 Other requirements: No  
 Volume m3 50

**LJ8.2****ADDITION FOR ALKALI FREE  
ACCELERATOR**

Location: Headrace tunnel  
 Other requirements: No  
 Volume of shotcrete m3 200

**Grouting, code GE (drilling) and GQ (grouting)**

Grouting is normally described on a cost-plus basis with a split between materials and time consumption.

It may look like this:

**GE1.1231113****DRILLING OF HOLE IN ROCK  
DIAMETRE UNTILL AND INCLUDING 150 mm  
UNDER GROUND – LENGTH**

PURPOSE: GROUTING  
 WORK PLACE: UNDER GROUND, AT FACE  
 TOTAL HOLE LENGTH: FROM 12 m UNTIL AND INCLUDING 24 m  
 Location: Headrace tunnel  
 Drill hole diameter: Maximum 64 mm  
 Tolerances: Collaring deviation maximum 100 mm, direction deviation at collaring maximum 2 %  
 Other requirements: No  
 Summed hole length m 30000

**GE1.181211****RIGGING FOR WATER LOSS MEASUREMENTS**

PURPOSE: GROUTING  
 WORK PLACE: UNDER GROUND, AT FACE  
 Location: Headrace tunnel  
 Other requirements: No  
 Number of times no 40

**GE1.1813111****WATER LOSS MEASUREMENTS**

PURPOSE: GROUTING  
 WORK PLACE: UNDER GROUND, AT FACE  
 DEPTH OF PACKER: UNTIL AND INCLUDING 3 m  
 Location: Headrace tunnel  
 Drill hole diameter: Adapted to grout holes  
 Pressure: Maximum 100 bar  
 Other requirements: No  
 Number of packers placed no 200

**GE1.18331113****CLEANING DRILLHOLE IN ROCK BY FLUSHING**

PURPOSE: GROUTING  
 WORK PLACE: UNDER GROUND, AT FACE  
 TOTAL DRILLHOLELENGTH: FROM 12 m UNTIL AND INCLUDING 24 m  
 Location: Headrace tunnel  
 Execution: Contractor's choice  
 Other requirements: No  
 Summed hole length m 30000

**GQ1.1****RIGGING FOR GROUTING**

WORK PLACE: IN ROCK, UNDER GROUND, AT FACE  
 Location: Headrace tunnel  
 Capacity of pump: minimum. 60 l/min at 75 bar work pressure  
 Maximum grouting pressure: 100 bar  
 Number of pump lines: 2  
 Type of grouting: deep grouting in rock  
 Other requirements: No  
 Number of times no 100

**GQ2.11****PLACING OF PACKER FOR GROUTING**

WORK PLACE: IN ROCK, UNDER GROUND, AT FACE  
 DEPTH OF PACKER: UNTIL AND INCLUDING 3 m  
 Location: Headrace tunnel  
 For drill hole diameter: Adapted to the grout holes  
 Maximum pressure: 20 bar  
 Other requirements: No  
 Number of packers placed no 1500

**GQ2.12****PLACING OF PACKER FOR GROUTING**

WORK PLACE: IN ROCK, UNDER GROUND, AT FACE

DEPTH OF PACKER: FROM 3 m UNTIL AND INCLUDING 5 m

Location: Headrace tunnel

For drill hole diameter: Adapted to the grout holes

Maximum pressure: 100 bar

Other requirements: No

Number of packers placed no 1500

**GQ2.13****PLACING OF PACKER FOR GROUTING**

WORK PLACE: IN ROCK, UNDER GROUND, AT FACE

DEPTH OF PACKER: FROM 5 m UNTIL AND INCLUDING 10 m

Location: Headrace tunnel

For drill hole diameter: Adapted to the grout holes

Maximum pressure: 100 bar

Other requirements: No

Number of packers placed no 1000

**GQ3.11****SUPPLY OF GROUTING MATERIAL**

TYPE OF GROUTING MATERIAL: STANDARD GROUTING CEMENT

Location: For use on the hole site

Requirements for grouting materials: Requirements are given in Appendix 5, section 9.

Other requirements: No

Quantity kg 300000

**GQ3.12****SUPPLY OF GROUTING MATERIAL**

TYPE OF GROUTING MATERIAL: MICRO FINE CEMENT

Location: For use on the hole site

Requirements for grouting materials: Requirements are given in Appendix 5, section 9.

Other requirements: No

Quantity kg 100000

**GQ3.13****SUPPLY OF GROUTING MATERIAL**

TYPE OF GROUTING MATERIAL: ULTRA FINE CEMENT

Location: For use on the hole site

Requirements for grouting materials: Requirements are given in Appendix 5, section 9.

Other requirements: No

Quantity kg 10000

**GQ3.21****SUPPLY OF ADDITIVES**

TYPE OF ADDITIVE: MICRO SILIKA

Location: For use on the whole site

Other requirements: No

Quantity kg 40000

**GQ3.22****SUPPLY OF ADDITIVES**

TYPE OF ADDITIVE: SUPER PLASTESIZER

Location: For use on the whole site

Other requirements: No

Quantity kg 10000

**GQ4.111****GROUTING WORKS**

WORK PLACE: IN ROCK, UNDERGROUND, AT FACE

Location: Headrace tunnel

Stop criteria: 1000 kg per drill hole

Other requirements: No

Time hour 1500

**EQUIVALENT TIME ACCOUNTING**

This is a system made in the 70'ies for risk-sharing practice due to variation in ground conditions. Appendix A2 in part F deals with regulation of construction time in case of exceeding rock support quantities by use of equivalent time accounting. This subject is dealt with in another article of this publication.

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Tel: +47 67 12 80 00, Fax: +47 67 12 58 40, E-mail: [post@sweco.no](mailto:post@sweco.no)

[www.sweco.no](http://www.sweco.no)

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## 04. SHARING OF RISK IN NORWEGIAN ROAD TUNNELLING CONTRACTS

FOSSBERG, Gisle Alexander

### SUMMARY

This paper addresses contract practice for road tunnels in the Norwegian Public Roads Administration (NPRA). The specifications are based on the drill and blast method and the bid – build contract model and the unit price systems. The NPRA regards the rock that we are tunnelling in as a construction material, and strengthening methods are determined by assessment of rock quality at the tunnel face. This implies that actual quantities may differ from the contract's bill of quantities. NPRA has developed a flexible contract for adjusting quantities for both strengthening ahead of the tunnel face and support measures, and a clause to adjust construction time accordingly.

### CONTRACT PHILOSOPHY

The Norwegian Public Roads Administration (NPRA) uses the drill and blast method for the road tunnels. There are some 1000 road tunnels. Most are short, being less than 1 km, and the longest is 24.5 km. Between 20 and 30 km new tunnels are excavated per year.

Typically, road tunnels in Norway are in hard rock. Due to the quality of rock, one regards rock as a construction material. Such construction material has weaknesses that need to be dealt with by reinforcing measures such as pregrouting, bolts, or sprayed concrete arches. In cases of little or no strength, full reinforced concrete lining is required.

Since the rock mass is regarded as a construction material, the assessment of the rock properties is necessary. It is of vital importance that both client and contractor have competent people at the tunnel face to assess the actual situation ahead and the needed support measures. [1]

We know that there will be surprises, so we normally use the unit price contract, which places the risk for varying ground conditions on the owner. The unit price contract gives a fair sharing of risk to the parties by the contractor bearing the risk for his unit prices covering his costs and overhead, and the owner bearing the risk for varying and unforeseen ground conditions.

Though we do not ask for different prices depending on rock quality, we often ask for separate prices for half the blasting length or dividing the tunnel face into portions. [2]

Before contracting, we register ground conditions and compile a report that becomes part of the contract documents. This report describes test results, in other words the facts, but in addition a part that describes ground conditions, based on the facts. This gives the owner a fairly good basis for which measures and which quantities we need to specify in our contracts, and also provides the contractor with information that he may use in calculating.

In our bill of quantities, we specify various support methods and stipulate quantities, trying as accurately as possible to stipulate the amounts that we expect will be carried out, as this gives the least surprises, and the truest picture of the scope of work. The contractor is paid according to the actual amounts carried out. [3]

Important objectives of our philosophy are safety under construction and safe tunnels, all the time bearing costs in mind. It therefore becomes important that:

1. we are clear on how we share risk
2. our tunnel contracts are flexible in handling varying ground conditions
3. owner and contractor interact to achieve the results we wish.

### RECORDING GEOLOGICAL CONDITIONS AT THE TUNNEL FACE

We have had examples proving rock fall accidents can happen in tunnels opened to traffic. This has led us to review in detail if our way of tunnelling is good enough, and we have made a few modifications.

After each drill and blast cycle, the rock is inspected along with classification of rock quality, in order to ensure that appropriate support measures are chosen.

In addition, time is set apart in order to carry out neces-



*Photo: Svein Skeide, Public Roads Administration.*

sary registration of the rock conditions, so we record exactly what is behind the visible surface once we cover it with concrete, water and frost insulation, fire insulation etc. This process also ensures that we have a record of what was encountered during tunnelling, as reference later to conditions behind the visible tunnel surface.

We have implemented an item in our bill of quantities for time used for registering rock conditions, so that the contractor may calculate and give a price for the impact the registering process has on his drill and blast cycle costs. This item includes alternatives of either the contractor or the owner registering rock conditions.

### **SHARING THE RISK ON SUPPORT MEASURES**

The NPRA now requires that manual scaling is carried out in order to get a clearer picture of rock conditions than scaling by machine offers. The various support measures, the common ones being bolts, sprayed concrete or cast concrete, are determined both methods and quantities at the tunnel face.

The owner and contractor have largely the same interests at hand in choosing appropriate support methods for a safe tunnelling environment. As owner, the NPRA describes various support methods, and stipulates quantities in the bill of quantities.

In practice the contractor and owner decide in common which methods for temporary support are to be used. We try to choose reinforcing methods that not only take the contractor's needs into account, but the owner's as well simultaneously.

As the contractor is responsible for the health and safety at the work site, the contractor has to have the deciding word on what amounts of the agreed method is necessary as temporary support.

By an EU directive on health and safety on construction sites, the owner is equally responsible for the tunnel environment being safe during construction. In addition, the owner is naturally responsible towards the tunnel users for the safety and stability of the tunnel as a whole. The owner consequently decides which permanent support measures are to be carried out.

By regarding temporary support measures and permanent support measures as a whole, and not two separate evaluations, we are able to reduce risks and tunnelling costs.

The methods and quantities for support methods were previously determined by the owner and contractor relatively freely. We have implemented a system that specifies more clearly which support methods and quantities are to be used, depending on rock classification.

**CONTRACT CLAUSES TO TACKLE VARYING QUANTITIES AND CONSTRUCTION TIME FOR EXPLORATORY DRILLING AND SUPPORT MEASURES**

We make important decisions at the tunnel face, both as to the need for measures ahead of the tunnel face and support at the face. A consequence is that there may easily occur a considerable difference between the stipulated quantities in the contract and the actual quantities as carried out.

To tackle this, the NPRA has defined “the 100 % rule” in our specification describing support [3]:

- The unit prices apply even if the sum of actual quantities as calculated in cost differ from the bill of quantities by up to ± 100 %.
- If this limit is exceeded (more than doubling the quantity), unit prices may be adjusted by negotiation.
- The adjusted unit prices may not differ from the contract’s unit prices by more than 20 %. Adjusted price shall be determined according to documented expenses.

This takes care of differing quantities, but not the fact that added quantities also have an impact on the contractor’s available time towards the date of completion. To handle also that aspect, we have introduced a contract clause we call “the equivalent time principle” for adjusting the total construction time depending on the applied support methods [2]:

- If the actual quantities for tunnel support vary in comparison with the contract’s estimated quantities, the completion time is adjusted according to values, for example:
 

– Manual scaling	1 hour/hour
– Bolts up to 5 m	12 bolts/hr
– Sprayed concrete (shotcrete)	6 m3/hr

- Concrete lining 0,1 m/hr
- Exploratory drilling and pregrouting 60 m/hr

- The total time for support measures is summed up in hours, both performed and described amounts from the bill of quantities.
- The difference (between accumulated values) is calculated.
- The contractor normally has a tolerance for added support measures (typically a week per year of construction time).
- When this tolerance level is exceeded, the exceeded time value is calculated as shifts and days, which are added to the completion time.

The method described above also includes a factor to take into account that a tunnel may have more than one tunnel face during construction. The values reflect the state of the art in Norway, methods and capacities today. The method has proved to be a useful tool useful for sharing the risk for both owner and contractor.

Together, these two clauses in our opinion remove some uncertainty regarding risk in our contracts, meaning that the risk that the contractor has to bear is fair enough. The owner must always bear in mind that risk has a price. In order to reduce the total construction sum, we must try to reduce the contractor’s risk as well.

**REFERENCES**

- [1] NPRA handbook 021 Vegtunneler (2006), and English version: handbook 021 E Road Tunnels (2004)
- [2] NPRA handbook 066 Konkurransgrunnlag (2008-02)
- [3] NPRA handbook 025 Prosesskode 1, Standard beskrivelsestekster for vegkontrakter (2007-11)

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Postboks 78 Laksevaag, N-5847 Bergen/Norway  
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## 05. COORDINATION - A WAY TO ENHANCED COOPERATION IN UNDERGROUND PROJECTS

HENNING, Jan Eirik

Contractual provisions concerning coordination are intended to lay a foundation for good collaborative relationships, to build trust between the parties and to create inspiration for the further development of the project. Coordination provisions may be made the basis of all types of contracts independent of contract form and type of work or job. The scheme and prerequisites for coordination must be made clear in the tender documents for each individual contract.

### THE OBJECT OF COORDINATION

The intention of coordination provisions is:

- to improve coordination between the parties
- to build trust between the parties
- to contribute to a shared understanding of the contract
- to help inspire innovation and development
- to help all the parties work together towards agreed goals, based on common expertise and experience.



### UNDERLYING PREREQUISITES FOR COORDINATION

- Competent and motivated employees of all parties
- Openness
- Equality between parties
- Respect for each other
- Predictability
- Establishment of agreed procedures for personal conflicts

- Establishment of agreed procedures in the event of disagreements or disputes of a contractual nature
- Clarification of roles and responsibility
- Establishment of procedures for coordination which create trust and inspiration for development

### BASIC CONDITIONS:

#### The tender competition and selection of bidder

The tender competition is conducted in accordance with standard procedures, until the selection of bidder and conclusion of contract. For public owners, this means that the whole tender competition is carried out in accordance with the Norwegian Public Procurement Act and associated regulations.

### COORDINATION AND DEVELOPMENT PHASE

To attain a shared understanding of the contract, a common objective and agreed coordination procedures which inspire innovation and development, to the benefit of all parties, the scheme for the coordination and development phase is of major importance for all further work.

The coordination and development phase should at the very least include:

Getting to know each other

- Establishing how to involve all parties (owner, contractor, consultants, performing entities etc)
- Developing common coordination procedures, including demands and expectations on the parties
- Clarifying organisation, roles and responsibility
- Clarifying procedures for conflict resolution, for issues relating to both contract and personnel
- Clarifying procedures for technical quality control, quality assurance and HSE (health, safety and the environment)
- Clarifying routines and requirements regarding documentation, reporting etc
- Developing a shared understanding of the contract

- Developing a shared understanding and objective of the construction job
- Reviewing and optimising progress
- Analysing and determining specific development potential and development targets

The above should be specified and detailed to the extent necessary, such that all parties find the result of the process useful, and also helpful for the implementation process. The coordination and development phase should be carried out without any change to basic conditions, responsibility and risk in relation to the preconditions in the tender competition.

Sufficient time should therefore be set aside for the coordination and development phase after the conclusion of contract to allow a thorough review of all aspects of the project and the contract work.

The time necessary for the coordination and development phase must be determined after an assessment of each project, taking into account its size, complexity and development potential. As a starting point, a period of four weeks may be set aside. However, if the parties agree, the coordination and development phase can either be ended and the implementation phase started, or it can be extended. Although the coordination and development phase should basically be completed before the works are commenced, it will also carry on as a continuous process after the start of the contract work.

The intention behind having a coordination and development phase laid down in the contract, and setting aside sufficient time before the start of the works, is that involved parties will, together, be able to establish coordination procedures and a scheme for further development of the project by combining good suggestions from the contractor, consultants and owner based on common expertise and experience.

The coordination and development phase is terminated after all relevant factors relating to the contract have been reviewed and the parties have acquired a shared understanding of what is to be achieved by organising and carrying out the project as described. The expenses that consultants and contractors incur by participating in the coordination and development period will be paid in accordance with rates given in the tender, based on the preconditions in the tender documents.

## **DEVELOPMENT OF THE PROJECT AFTER THE WORKS HAVE STARTED**

After the coordination and development phase has

ended and the works have started, it will still be possible for the parties to propose new solutions.

## **SHARING OF COST SAVINGS RESULTING FROM DEVELOPMENTS**

The contract provisions must include provisions indicating the parties' sharing of cost savings. Cost savings are achieved through agreed alternative solutions which are put into practice. Improvements are usually remunerated by 50% of the net saving obtained in relation to the contract sum.

## **EXPERIENCE**

Experience of the effects of coordination is gradually accumulating. The Norwegian Public Roads Administration has worked with this technique, among others, for a number of years and in view of the positive effects it has seen, it has now incorporated standard provisions in its tender documents which state that coordination prior to start-up of the contract work is to be implemented. The following may be mentioned as examples of positive effects:

- Collaboration between owner and contractor has been good from day one.
- The coordination phase led to a considerable amount of time being spent together, which has resulted in good communication.
- A coordination phase prior to construction start-up has led to well-functioning collaboration in the implementation phase.
- Strong commitment results in many proposals for developments and new solutions, but many basic conditions have led to proposed solutions not being put into practice.

## **CHALLENGES**

- Being open to the process and ideas that crop up
- Low threshold for making suggestions
- Involvement
- Competent, motivated and suitable people from all parties
- Equality between parties
- Decision-making authority
- Unambiguous and clear framework for the project such as design guide, zoning plan, handbooks etc.
- Completion of the coordination phase prior to construction start-up

## **FINAL EVALUATION**

The parties should, together, draw up a final report in which all aspects of the contract work and coordination are discussed.

## 06. AN OIL COMPANY'S APPROACH TO UNDERGROUND CONSTRUCTION CONTRACTS

KORSVOLD, Jon  
HANSEN, Jens Petter

### INTRODUCTION

In Norway Statoil at present operates more than 35 unlined rock caverns for storage of hydrocarbons. Multiple tunnels for sea water cooling systems have been constructed. Pipelines from the offshore developments have been pulled ashore using both tunnel and advanced Horizontal Directional Drilling (HDD) techniques. A subsea tunnel for road access to plant facilities has been commissioned. The construction works are typically carried out in hard rock in challenging topography and harsh climate along the Norwegian coast. Evaluation and selection of specific construction and contract strategies related to underground facilities are parts of the process to conclude execution of a project. The concept planning phase concludes the main principles and selects the way forward with regard to contract breakdown and interface scope. The basic scope for the various contracts is defined in this phase.

### MAIN PROJECTS LAST DECADE

The Snøhvit Greenfield project for the Hammerfest LNG plant at the very north of mainland Norway included the construction of a 2.3km subsea tunnel to 62m below sea level for road access to the LNG plant at the island of Melkøya. A tunnel system provides for sea water intake at -80m feeding the plant process cooling system. The outlet tunnel discharges the cooling water at -30m. These scope items were planned as an

integrated part of extensive above ground civil works including excavation of more than 2 million m<sup>3</sup> of solid rock to level the site. A dock for the 150x50m barge with the main LNG plant process unit was prepared. The overall rock excavation ensured a local cut and fill balance and provided specified fills to reclaim sea areas. Large quantities of various fractions of crushed rock were produced. The rock excavation methods were tailored to produce shore protection materials including up to 35tons boulders for a rubble mound breakwater.

The gas processing plant at Nyhamna for the Ormen Lange field development is located at the coast of Romsdal southwest of Trondheim in Mid Norway. This Greenfield project included tunnels for the sea water cooling system similar to those for the Snøhvit project. Unlined rock caverns for storage of 180000m<sup>3</sup> of stabilised condensate and 60000m<sup>3</sup> of off-spec condensate were excavated. The water curtain system was installed from a tunnel system above the caverns to avoid construction works in the rugged scenic landscape above. The site preparation required excavation of approx. 2.5 million m<sup>3</sup> of solid rock and removal of more than 1 million m<sup>3</sup> of soil to level the site. Large quantities of crushed rock were produced to construct road systems and provide quality back fill and aggregate materials for the other construction contracts to follow.

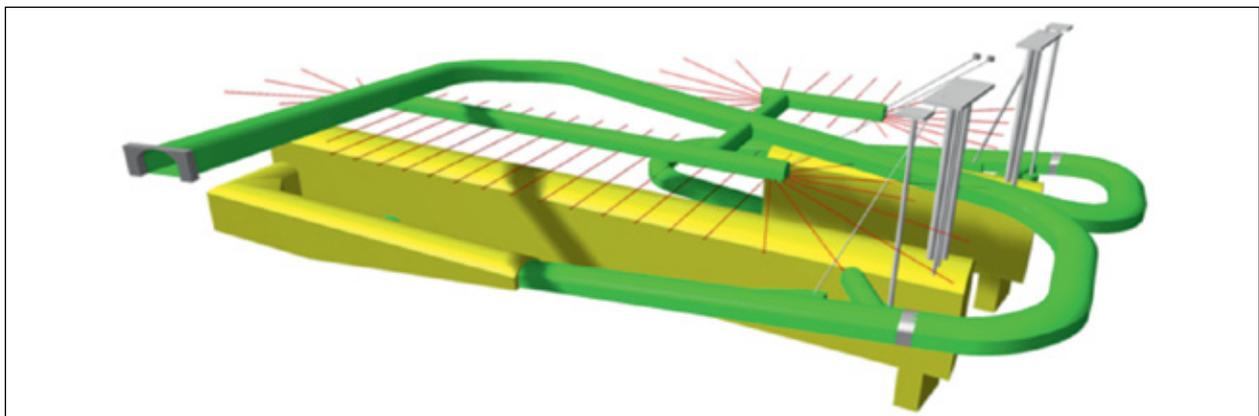


Fig. 1 Ormen Lange condensate and condensate off-spec caverns with water infiltration system

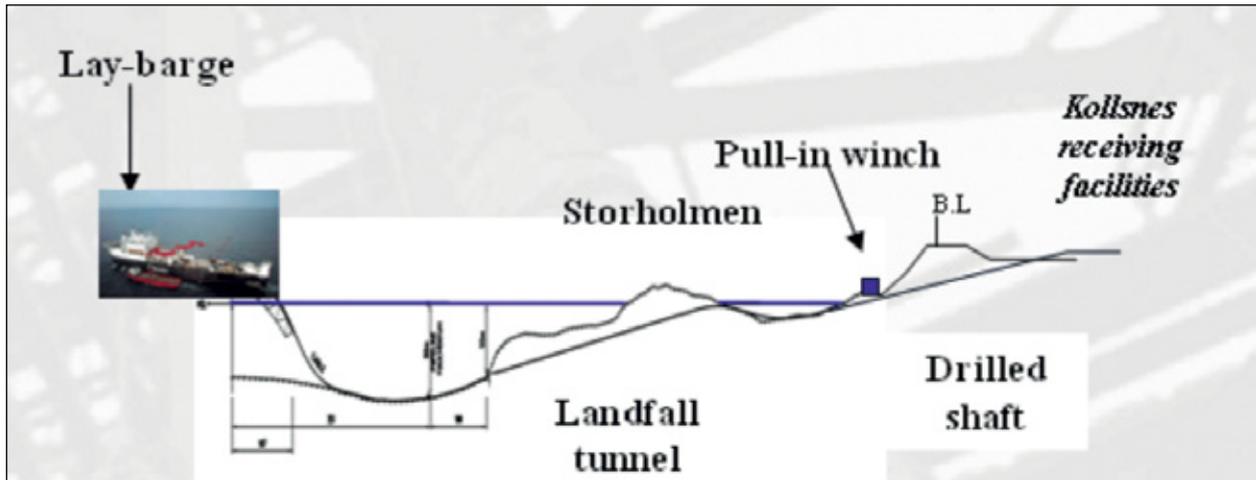


Fig. 2 Kvitebjørn pipeline landfall concept at Kollsnes gas processing plant

The 30" pipeline from the Kvitebjørn offshore field development enters the Kollsnes Troll gas processing plant west of Bergen through a 400m landfall tunnel constructed from the nearby islet Storholmen. The piercing point is at 66m water depth. The pipeline route passes a small strait prior to arriving at the pull-in site just outside the Kollsnes plant fence. The pipeline was pulled in from the lay barge, through the tunnel and across the strait to shore. The Kvitebjørn pipeline from here approaches the Kollsnes receiving facilities through a 60m drilled shaft (HDD) avoiding all existing plant installations.

At the Mongstad refinery north of Bergen a 12" gas pipeline from the Kollsnes gas processing plant was successfully landed as part of the EVM project. Access from only the top end of the HDD bore hole was possible. Use of an unlined bore hole was targeted. The project contributed to advancement of the HDD technique in hard rock with respect to entry angle (45 degrees), drill bit design, bore hole rock stabilising methods and advanced steering tools to comply with strict pipeline alignment tolerances. During pull-in the pipeline entered the 400m unlined 20" bore hole at 230m below sea level at the bottom of an almost vertical subsea rock face at the landfall site.

A new unlined rock cavern for storage of liquid propane at -42 degrees was constructed at the Mongstad refinery. The cavern top was located 50m below sea level. The work included construction of raise drill shafts for product infill, pumps and instrument functions. The water infiltration system was installed by drilling horizontal holes from a tunnel system above the cavern and by vertical holes from the plant grade level. The scope included the initial cool down of the cavern by cooled air to freeze the surrounding rock. Descriptions

of several of Statoil projects may be derived from the documentation listed under References.

## PLANNING

Typical for our Norwegian projects has been to allocate the planning and design task to a civil engineering contractor having a proven track record related to underground facilities and in depth knowledge of the special requirements related to oil and gas projects. The scope has often included site preparation works for plant facilities to allow for integral planning of the overall and local cut and fill balances. Knowledge of interface handling towards the design contractor(s) for the process plant and the understanding of the requirements to the extensive documentation needed by all involved to manage and control a mega oil and gas project is normally mandatory.

The civil engineering contractor has typically prepared the technical part of the invitation to tender for the construction contract, being awarded and administered by Statoil. This has resulted in the construction contract having a very limited detailed engineering scope as the civil engineering contractor often also prepares the approved for construction drawings.

The Section 2 described underground facilities projects illustrate the importance of properly evaluating and planning the overall project civil scope, interfaces and risks involved as basis for defining which scope should be included in the various contracts. In Statoil a formal Capital Value Process (CVP) for investment project development has to be complied with. This entails a stepwise approach measuring the maturity of the project development at pre-defined Decision Gates (DGs).

CVP is a structured and comprehensive approach to project identification, planning and execution, where



various contracts is defined in this phase. Identification and optimisation of interfaces are done in order to minimise the risks involved.

A main issue in the planning phase is the selection of the overall plant construction philosophy, including the split between stick built and modularised construction of the plant. The use of underground facilities, i.e. exploiting the local geology could offload the need for installation of large bore piping for cooling water intake and outlet, and similar surface area and steel for atmospheric tank farm construction by instead using a rock cavern system.

At DG2 the procurement way forward has to be selected for the civil works including underground facilities. This is mainly driven by the fact that the civil works typically are the initial site construction activity and often constitutes the critical path. The Front End Engineering Design (FEED) or Definition phase therefore has to include preparation of invitation to tender documents for the civil works and necessary detailed design to be able to award construction contracts subject to DG3 approval. This calls for extensive preparation for execution planning during FEED to manage and administer a civil construction contract from day one upon project sanction.

## HSE

The term HSE includes health and hygiene, working environment, safety, security, climate, and environment protection. The Statoil ultimate vision for its operations is zero harm to personnel, environment and assets. Specific targets are established for the projects based on corporate targets. This is typically stretching the industry standard for HSE performance for underground construction works. Statoil expect the large efforts and resources put in to pay off also in economical terms.

Despite the focus and efforts related to safety in projects, fatal accidents during construction have occurred. This demonstrates the need for further improvement of safety level related to rock works and should be considered a major challenge to all involved parties. The project manager owns the HSE risk for his area of responsibility, and shall at all times have an overview of the risks. HSE is a line management responsibility.

HSE risk analysis is used as a decision and verification tool according to legislative and corporate requirements and to verify compliance with the project's acceptance criteria. All projects prepare an HSE program applicable for each phase. This program shall at all time

reflect the project's identified HSE risks and challenges including those related to contracts and describe plans for execution of necessary mitigation actions. The contractor is obliged according the contract to prepare his own HSE program based on the project HSE program and provide input to company risk processes. Accidents and incidents by contractors shall be notified, reported, investigated and followed up.

All projects shall have a local emergency response plans. The construction contract specifies how the contractor shall plan and operate within this framework. Projects shall assess security threats and vulnerability and prepare plans for local security measures. Special attention is given to access control systems to underground facilities. To achieve ambitious HSE targets with respect to site safety collaboration between the contract parties, extensive training, controls and continuously attention to HSE issues is required. The following examples illustrate this

- Regularly meetings between contractor and company management to ensure involvement and commitment
- Mandatory HSE courses for all prior to start working at the construction site
- Specialised courses for critical activities (use of cranes/lifting, etc.)
- Safety on top of the agenda at all meetings
- Reporting of unwanted incidents (observations)
- Analyses of incidents and observations to identify trends
- Safe Job Analysis (SJA) prior to start of new activity
- Frequent meetings with all construction workers, every quarter more extensive gathering
- Investigations of incidents to identify route causes and mitigations
- Time-out at severe incidents to reflect, analyse and train
- Campaigns due to identified trends, new risks or season

Special attention is paid to planning and monitoring of working environment in tunnels and caverns during construction works related to ventilation systems and toxic emissions from the construction equipment and explosives used.

Treatment of water from tunnel and caverns works is subject to specific requirements and monitoring.

## RISK

A risk management process is applied and includes the evaluation of opportunities. The process is used for all project phases and typically includes:

- Establish/define context
- Identify and analyse risks
- Evaluate risks
- Decide related actions
- Implement action, monitor, and follow-up risks
- Interaction with cost- and schedule risk analysis

The risk process involves both the company project team and applicable contractors to ensure involvement of management and experts for all relevant parties and disciplines. Specialised IT-tools are used to manage the process and results. Below are some examples of risks that in spite of the very best intentions, extensive planning and project actions still may materialise:

- Rock and soil conditions turn out different than anticipated
- Weather downtime is different from what could reasonably be expected
- Unsuccessful piercing to sea from a subsea tunnel for cooling water
- Insufficient injection at tunnel face to ensure integrity of tunnel and compliance with limitations to water ingress
- Severe accident at the construction site

The planning must provide for expertise involvement, schedule float towards critical path, cost allowance and change handling systems to avoid jeopardizing the overall contract and project completion milestones. The systematic approach to risk shall ensure that aspects related to HSE, constructability and operability are addressed during design. The tender documents and proposal for contract should be evaluated prior to inviting for tenders related to risk for disputes related to specific identified risks. The contractor must as part of his tender identify the major risks he envisage and how he plans to be mitigate these during execution of his work.

### TECHNICAL DEFINITION

The basis for the technical definition is the project design basis including the functional requirements to the facilities. To be able to perform a robust concept selection during the Concept planning phase in depth technical studies are normally executed when underground facilities are part of the project scope. The concept and technical solution is often subject to verification by 3rd parties with respect to technical aspects as well as schedule and risk.

The concept selection has to be based on site specific geotechnical and geological surveys to establish the necessary technical design parameters. Supplementary studies will have to be conducted at latest upon DG2

when commencing the Definition phase to be able to utilise this information as basis for the Invitation to Tender documents. Upfront investment in quality site surveys usually pays off and is an effective risk reducing measure. Requirements to supplementary site investigations during construction as work progresses are normally specified in the construction contract scope.

The underground facilities design is normally well advanced as basis for tendering the construction contract. This limits the possibility for future surprises and reduces the construction contractors risks and hopefully the price.

Typically the design prepared by company shall be tendered. The contractor may offer alternatives under specific terms and is sometimes invited to offer and price different technical options for specific items. Concrete works and outfitting structures are typically part of the contract scope for underground facilities.

Battery limit for the project scope and interfaces to others have to be defined. This is in the contract supplemented by administrative requirements to ensure that the battery limits are adhered to and the interfaces are properly handled. The interface towards the contractor installing the process plant equipment requires special attention. For a modification project the interface relation to plant operation requires special procedures and resources. Requirements to the minimum tunnel or cavern profile are specified including tolerances. Maximum water ingress and other functional requirements are defined. The requirements are supported by references to national standards. The technical requirements are for tasks like application of grouting or shotcrete supplemented by references to industry standard and acknowledged best practice documents as developed by Norwegian Tunnelling Society (NFF).

Requirements are implemented to ensure proper definition of rock support to ensure the overall long term integrity and functionality of the underground facility. The contractor is responsible for the rock support measures to ensure safe construction work at all times in the tunnel or cavern. As construction works progresses collaboration between the company and contractor engineering geology expertise is required.

Requirements to documentation of contractor deliverables as well as documentation for the operation phase are specified.

## COMPETITIVE TENDERING

Statoil's procurement process is based on competitive tendering and on the principles of transparency, non-discrimination and equal treatment of tenderers. Statoil develops, integrates and implements procurement strategies to achieve the best possible agreements for the group. This is achieved through a category-based approach to goods and services, based on a coordinated control of demand, the global market situation and robust analyses in order to minimise risk in the execution phase. The suppliers must be prequalified in order to compete for tenders.

Based on the defined scope and contract breakdown Statoil prepare tender documents and plans for the individual procurement packages (contracts). The plan typically includes main activities with estimated duration as:

- Scope definition and preparation of tender documents
- Preparation of bidders list (Statoil uses the pre-qualification system Achilles to search for qualified tenderers)
- Invitation to tender
- Tender phase
- Tenderers submit clarifications to the tender documents
- Evaluation phase
- Bid opening, technical and commercial evaluation
- Preparation of evaluation report with recommendation
- Award

Detailed requirement related to HSE issues are incorporated in the procurement processes. Statoil has strict requirements for CISR (Corporate Integrity and Social Responsibility), ethics and HSE. Commitments are based on Statoil standards for contract documents, frame agreements and purchase orders.

## COMPENSATION

Engineering contracts are typically reimbursed based on tendered rates with agreed man-hour limit per activity defined in Cost-Time- Resource sheets (CTRs).

For construction contracts the typical compensation format is developed on the basis of Norwegian standards with fixed lump sums for preliminaries and unit rates for the majority of the construction scope. Construction contractor is normally compensated as per agreed executed quantities. Unit prices and estimated quantities for rock support measures envisaged have typically been included in the contract. Lump sum elements usually have separate payment schedules. Failure to meet progress milestones will result in payment of penalties as per contract.

## CONTRACT ADMINISTRATION

The administrative requirements applied in our engineering and construction contracts are more comprehensive and detailed compared to contracts typically awarded to the civil construction industry. This to ensure that all company and contractor obligations and liabilities are properly taken care of and that necessary reporting as basis for aggregation for the overall management of the project including handling of deviations, changes, emerging risks, etc. is made.

Handling of changes to the contract is covered in the Conditions of Contract for the contract. Communication between the parties is dealt with in the Administrative appendix in the contract. Detailed requirement to planning of the work and progress reporting are also included. The same applies for HSE, document handling, quality assurance, documentation of deliverables, etc.

Attention and involvement by both project and corporate management from both parties are key success factors to ensure deliverables according to contract. This requires collaboration and time. HSE performance and progress issues are key items at the agenda.

Usually Statoil applies a Project Completion System to document that all items are delivered as specified and that a defined facility items (typically equipment) are ready (mechanical complete) for dynamic testing as part of a process or utility system. The completion system is tailored to control readiness for commissioning of complex plant process and utility systems. Selected items of underground facilities are included to track completion status.

Construction contractor typically prepares redline mark-up on the construction drawings to reflect actual situation and alterations. This will be the basis the engineering contractor to prepare as built drawings that will be part of the Life Cycle Information (LCI) documentation to be handed over by the project to operation.

To ensure during construction the necessary quality of the day to day decisions with respect to tunnel integrity and rock support measures, engineering geologists have to be mobilised during construction. Their evaluation will have to cover the requirement to investigations of the rock conditions in front of the tunnel face, the immediate measures for rock support for safe working conditions until next blast and the permanent rock support for the lifetime of the facilities.

## WAY FORWARD

Our past experience will provide the basis with respect to planning and contract strategies for underground

facilities in rock for future oil and gas projects. The expertise shared in Norway between clients, research institutes, engineering and construction contractors and others during decades of systematic experience transfer by professionals within the field of rock works is unique.

The combination provides Statoil with a solid base for evaluation of new projects in Norway or internationally and should be a competitive edge when evaluating concepts and applications for new projects abroad. Location of facilities and functions in rock will provide solutions that could result in benefits both with respect to operability, HSE, schedule, risk and value creation.

Compliance with our governing requirements and the systematic work process to define a robust technical concept and project execution are the corner stones for successful hand-over of underground facilities to operation.

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Phone + 47 48 22 33 95

## 07. PARTNERING AGREEMENT FOR SILA

PEDERSEN, Ann

### INTRODUCTION

The background for the SILA expansion is this: LKAB's ore treatment plant at the time was old, outmoded and highly resource-demanding to operate.

Upgrading SILA in Narvik by constructing a whole new storage and discharging structure will boost efficiency and enhance the environment.

LKAB decided on a new concept, including the construction of an approx. 600 m concrete culvert for unloading trains, 13 large underground storage silos for storing the iron ore from the Kiruna mines, and about 2.6 km of underground tunnels for conveyor purposes.

LKAB asked six contractors in northern Europe for a presentation and settled on Leonhard Nilsen & Sønner AS as partner. In December 2005, a partnering agreement to the tune of approximately NOK 800 million was signed. The contract was designed as a turnkey project, but LNS also has a number of subcontracts designed as turnkey projects.

Construction began in January 2006 and was completed in November 2009.

### LNS:

LNS are an attractive collaborative partner, both domestic and international, specializing in road and tunnel construction, bulk transport and underground mining operations. Years of active operations on Svalbard have helped us acquire unique expertise in polar logistics.

LNS are involved in mining operations several places in mainland Norway, and on Spitsbergen. In the Antarctic, LNS Spitsbergen was hired to construct satellite antennas for NASA and the ESA, and intends to build its third Indian station, Bharati in Antarctic for National Centre for Antarctic and Ocean Research (NCAOR), India.

### LKAB:

Luossavaara-Kiirunavaara AB (LKAB) is an international high-tech minerals group, one of the New World's

leading producers of upgraded iron ore products for the steel industry and a growing area supplier of industrial minerals products to other sectors. LKAB runs the largest underground iron mines in the world.

### PRIOR TO ENTERING INTO AN AGREEMENT

LKAB's objective with the "SILA" project was to carry out a comprehensive rebuilding of the iron ore port in Narvik. Preliminary planning, which considered the future structure of the port, was initiated in 2002. After this preliminary planning, a more thoroughgoing collaboration was established between LKAB and LNS during the so-called planning phase.

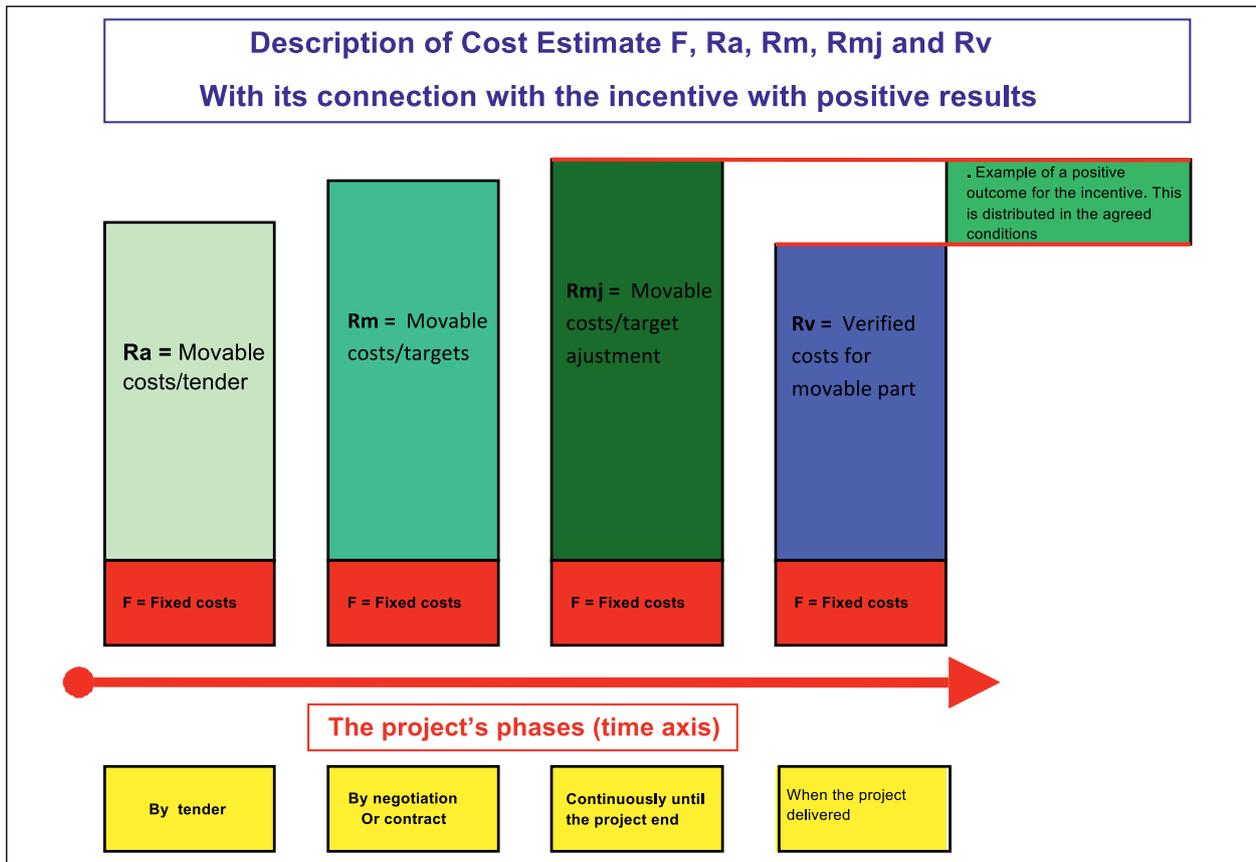
Comprehensive investigative and layout work has been carried out jointly by the partners. LNS has expended considerable resources and has participated in and played a major role in the planning. LNS have also had responsibility for producing the requisite reports, technical solutions, tenders for subcontracts and deliveries, as well as cost estimates.

On account of its extensive participation, LNS has assumed special responsibility for the success of the project's implementation.

After a lengthy collaboration, LNS AS entered into a Partnering Agreement contract with LKAB in December 2005, to the tune of approx. NOK 800 million for the construction of a completely new storage and discharging facility in Narvik, with silos built into the solid rock.

The Partnering Agreement was drawn up in such a way that it was in the interests of both parties to achieve stated goals. Positive deviations were financially beneficial, whereas negative deviations were "punished" financially.

The project was divided into a fixed section, HD 00, and a flexible section. The flexible section was then technically divided into 15 main parts, called HD 01, 02, 03 (A, B and C), HD 04 – HD 15.



- F = Fixed costs. F shall not be subject to indexation.*
- Ra = Movable costs/tender. Full price without mark-up.*
- Rm = Movable costs/targets. Rm was to be determined by the parties so that it provided propitious conditions for a positive incentive outcome.*
- Rmj = Movable costs / target adjustment. Adjustive target costs. During the project, on an ongoing basis, the target costs are adjusted (Rm) along with changes in quantity.*
- Rv = Verified costs for movable part (full price without mark-up).*

During the innovation phase (first quarter, 2006), the partners were to establish a target document. This document was to be based on complete openness and cooperation in matters involving purchasing, finances and the simplicity of the follow-up.

The Partnering Agreement was drawn up as a turnkey contract – in other words, work as you go. All sub-contracts are also included as turnkey contracts, with each contractor responsible for the detailed planning of its particular delivery.

This "double contract" would prove challenging in terms of how to interpret the contract relationship, which will be dealt with later in this article.

**PARTNERING AGREEMENT**

A partnering agreement is a form of collaboration in which the builder, consultants and contractors establish,

early on, an open and trusting collaboration in a construction or plant project. Such partnering agreements must be drawn up in a way that they promote a common interest in keeping costs as low as possible. The parties must together arrive at a target price which, in the subsequent implementation phase, will serve as a mutually binding guideline. Accrued costs will be continuously assessed against the final cost forecast.

A partnering agreement encompasses a set of joint goals, in which trust and mutual respect are far-reaching. It also sets forth the parties' responsibilities and moral obligations. Such a partnering agreement can be employed in cases where collaboration is close-knit.

The Partnering Agreement describes an incentive model that regulates the parties' joint risk and potential. An incentive agreement gives the parties a common interest in minimizing costs.

Accrued costs will be continuously assessed against the final cost forecast.

The Partnering Agreement can be characterized as follows:

- a. The builder and contractor have a common goal and share the risks.
- b. The target price and joint incentive agreement yield common financial interests.
- c. Open finances and joint purchasing
- d. Potential for rapid start-up of the project
- e. Mutual respect – and dependency
- f. Problems are not ignored; a close dialogue is maintained in order to avoid conflicts.
- g. Open, trusting and interdisciplinary collaboration. The parties “join forces” so that they can exploit each other’s strengths and skill sets.
- h. Everyone has a “win-win” mindset and acts on it.

The following can be achieved:

- 1. efficient building sites
- 2. a flexible building process
- 3. greater job satisfaction

How the Partnering Agreement differs from ordinary contract agreements:

- One makes the transition from being a party in the matter to becoming a partner on the project.
- As opposed to traditional contracts, the contractor and other important term providers are all involved, even during the project’s conception and development phase, and these all collaborate closely with the client throughout the life of the project.

A partnering agreement is first and foremost an intelligent way of collaborating, one in which openness, honesty, respect, trust and common goals are all important factors. The industry can also achieve a better reputation with this type of contract.



**PROSJEKT SILA**  
**PARTNERINGDEKLARASJON**



Vi har som deltakere ved workshopen i Narvik 12-13/1-2006 besluttet å arbeide ut fra nedenstående visjon, mål og suksesskriterier ved gjennomføringen av prosjekt SILA.

**VI skal bygge verdens beste malmhavn**

**Partnering / samarbeide**

- Prosjektet skal drives i positiv ånd
- Vi skal skaffe oss fullstendig oversikt over prosjektet og dets risiko
- Vi skal nyttiggjøre alle parter styrke og kompetanse og utvikle partnering som samarbeidsform
- Vi skal ha felles informasjonsrutiner (internt/eksternt)
- Vi skal ha felles mål og ansvar for problemløsninger

**Funksjon/Arbeidsmiljø.**

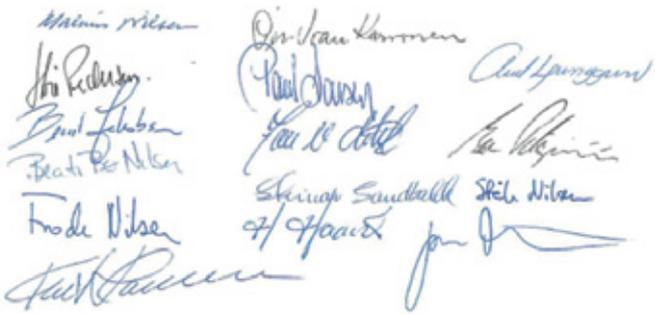
- Med riktig HMS-arbeide skal vi sikre et godt ytre og indre arbeidsmiljø
- Vi skal sikre malmløseransene og få en fornøyd bestiller av SILA

**Tid**

- Vi skal gjennomføre rett arbeid til riktig tid

**Økonomi**

- God driftøkonomi gjennom hele byggetiden skal gi førtjeneste til ALLE parter



**SILA = Sosial, Intens, Logisk, Alle**

[Social, Intensive, Logical, All]

**SILA – Partnering Agreement – objective**

LKAB and LNS joined forces to build SILA – with optimal functionality at the lowest price in the shortest time and with the primary focus on security (HSE). The intended result: “the world’s best iron ore port.”

[Logo]

PROJECT SILA

[Logo]

**PARTNERING DECLARATION**

As participants at the workshop in Narvik on 12-13 January 2006, we have resolved to proceed on the basis of the vision, goals and criteria for success below in our implementation of the SILA project.

**WE are going to build the world’s best iron ore port.****Partnering / Collaboration**

- The project will be managed in a positive spirit.
- We will acquire a complete overview of the project and its risks.
- We will draw on the parties’ strengths and competence and develop partnering as a form of collaboration.
- We will have common information routines (in-house and external).
- We will have common goals and responsibilities for resolving problems.

**Function / Working Environment**

- With the right HSE, we will ensure a good external and internal working environment.
- We will guarantee deliveries of iron ore and have satisfied orderers of SILA.

**Time**

- We will do the right work at the right time.

**Finances**

- Good business economics throughout the building period will yield savings for ALL parties.

[15 signatures]

**SILA = Social, Intense, Logical, All**

## EXPANSION PHASE

After several years in development, the project was ready to start up in January 2006. LNS began soil and rock work while detailed planning was in its infancy. LNS carried out this work itself. All other work was sub-contracted out: concrete, steel, VVS, mechanics, electricity, etc. Nine turnkey sub-contractors were signed (with NCC, Sandvik, T. Jespersen, Rørlegger'n, Siemens, NNM, Bamek, Hägglunds and Munck Cranes). The sub-contracts were finalized in the spring and summer of 2006. As each agreement came into force, detailed planning for each respective field began. In negotiating and signing all the sub-contractor agreements, LKAB and LNS acted as a joint orderer and contract partner. LKAB/LNS acted in unison with respect to the sub-contractors. This relationship was maintained throughout the entire building process. In all major negotiations and conflict situations with UE, LKAB/LNS stood united as “the builder.”

### Partnering in practice:

The builder LKAB and the contractor LNS had a close collaboration. LKAB and LNS established a joint organization plan. This manifested itself in a large number of functions: HSE management, quality assurance, CE labelling, planning management and “technical construction supervisors.” During the first part of the project, the person in charge of finances was a joint representative. Finances followed the open book principle, in which LKAB had full access to LNS’ costs, time sheets, etc. All UE contracts were entered into jointly and, of course, LKAB had full access to information on all prices and contract terms.

From the outset, a joint office rig was set up for the facility, with a common meeting room and mess hall. One positive measure that fostered cooperation and a sense of community was the regular joint lunches that were served in the mess hall every Tuesday and Thursday.

From time to time, workshops were held as well; these were intended to “knit us together” and strengthen our sense of community.

- Every fortnight there were partnering meetings where the focus was on the relationship between LKAB and LNS, and where only LKAB and LNS met together. All outstanding issues involving LKAB and LNS were resolved in this forum, with the result that at building meetings, planning meetings and progress meetings, LKAB /LNS spoke with one “voice” in the dialogue with the sub-contractors.

### Takeover, final settlement and guarantee period

Also, all take-over proceedings with turnkey sub-contractors were handled jointly by LKAB and LNS. Thus, the final hand-over between LNS and LKAB was a mere formality. All final settlements with the sub-contractors were also handled jointly. There were some “interface” problems, with some uncertainty as to who the formal contracting parties were. Such matters were amicably and satisfactorily resolved because the parties were magnanimous and refused to get bogged down in formalities.

### LNS can summarize the advantages of the Partnering Agreement with SILA as follows:

- a. Close-knit collaboration – a good dialogue.
- b. Access to all documents (no secrets).
- c. Plenty of opportunity for quick decisions.
- d. A clear-cut willingness to make changes.
- e. The parties worked together to find solutions.
- f. The parties had a common goal – at all levels,
- g. and shared a joint financial result (profit/loss).
- h. Minimizing the financial risk between the parties.
- i. Savings that accrued as a result of many joint functions.
- j. Minimized risk for law suits.

### LNS does not envisage many disadvantages with the Partnering Agreement

- k. From the contractor’s viewpoint, one could say that it was a disadvantage that the benefits of smart solutions and successful negotiations had to be shared with the builder.

### SILA – challenges with the Partnering Agreement

- The biggest challenge of the SILA Partnering Agreement, I maintain, was the understanding of the contract that resulted from the turnkey contract being the basis for the Partnering Agreement. The settlement principles in these two types of contract are not necessarily compatible. It would have been good if this had been made explicit beforehand. The partnering model that was made the basis of the contract did not take into consideration the turnkey contractor model’s settlement principles. The contract bore some of the earmarks of being a copy of other types of contracts and of not being specially adapted to conditions at SILA.
- The fact that the planning and construction work went hand-in-hand, and that LKAB, a half-year into the building, period chose to make a major layout change in the project, presented a major challenge. The consequence of this layout change was a proliferation of changes in every technical area, which led to hectic replanning; this presented a challenge to the progress of the project and – not least – its financing.

- Furthermore, it should be said that it was a challenge to keep the focus on the collaborative spirit (not to become a traditional contractor and builder). This was particularly the case in situations where there was disagreement with UE as to what was included in their turnkey contract and, in this connection, how the same situation should be dealt with in the Partnering Agreement between LKAB and LNS.
- In situations where one was "banging one's head against the wall," so to speak, the focus on the collaborative spirit was put to a severe test.
- Because detailed planning was taking place while construction proceeded apace, there arose a continuous need to resolve major and minor problems. In such situations, the collaboration came under great pressure. But for the most part, LNS and LKAB were able to stand united in these situations.
- The project was huge, and it involved much of the consultancy environment in Narvik. Consultants were hard pressed for time, and there were occasions when it was hard for the planners to keep pace with the contractors' construction tempo.

#### Partnering Agreement – a summary of our experiences with SILA:

- Can be easy to assume the "old role" (builder/contractor).
- The potential for savings – joint functions.
- The potential for flexible solutions with respect to clarifications and decisions.
- Inherent in the understanding of the contract: Norwegian and Swedish are two different languages.
- The potential for a good result and a climate of cooperation depends on:
  - a. a good agreement.
  - b. unambiguous,
  - c. a common understanding,
  - d. a good work-up of financial "incentives (the carrot)"
  - e. players and an environment that are ripe for such a collaboration.
- Exciting concept – whets the appetite.
- Has given the Narvik area a lot of competence in the partnering concept, but also invaluable experience in collaborating on a major project.
- SILA – An excellent trial run for the next major project!
- Could be the key to good project collaboration.



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## 08. ALTERNATIVE FORMS OF CONTRACT - TARGET PRICE CONTRACT

ISLANN, Øyvind

### INTRODUCTION

As the title indicates, this article concerns an alternative form of contract called Target Price Contract. The article is based on and draws most of its examples from the Nykirke passing track project [1].

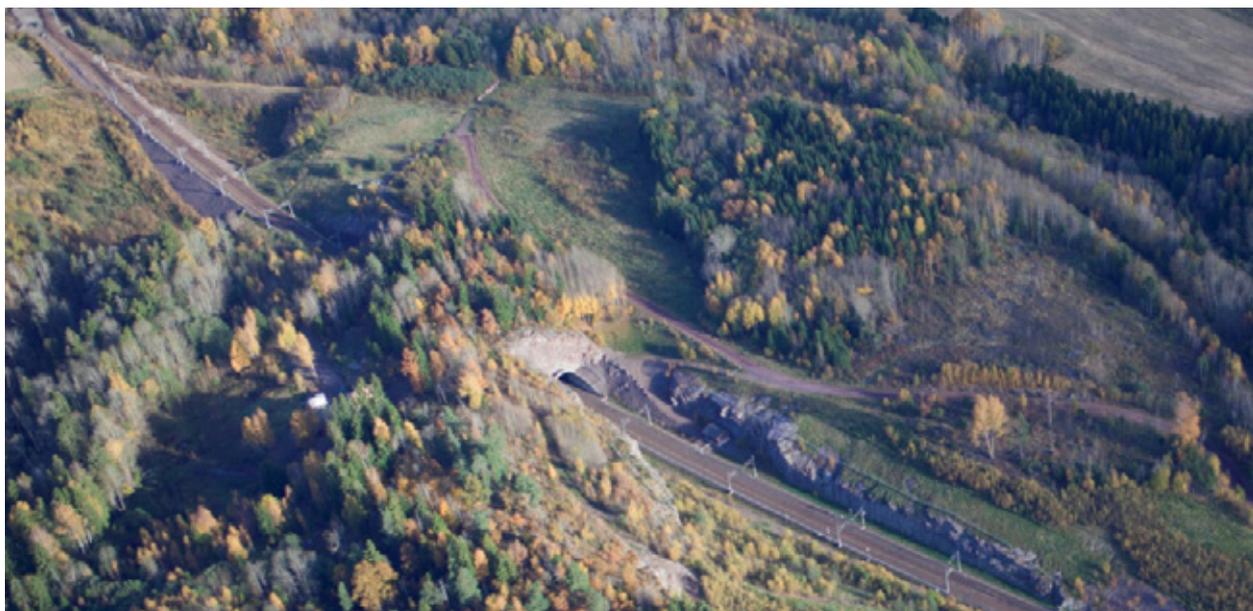
In reality, the project was a collaborative contract. This form of contract is known to not have any clear, single definition and the choice of name in this project must be seen in relation to the Administration's objectives:

- Lower costs
- Better solutions
- Better collaboration

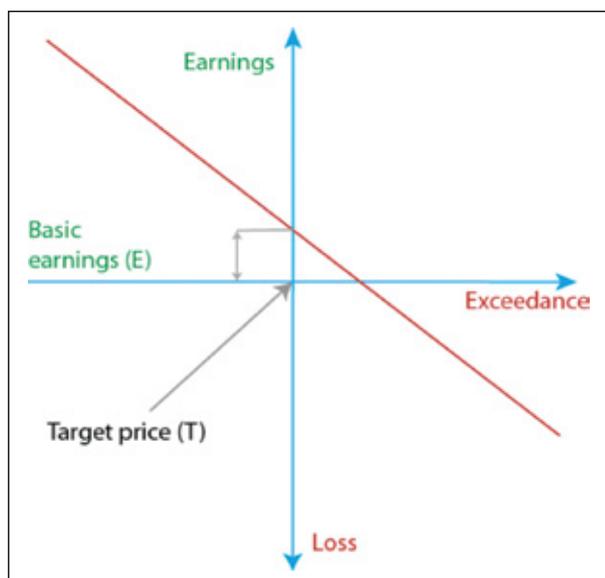
The principle objective in this project was lower project costs. Use of the target price contract for substructure work reduced construction costs, and undoubtedly gave rise to a good climate of collaboration.

As is usually the case for collaborative contracts, target price contracts are a type of contract in which the participants enter into an alliance to achieve optimum exploitation of their individual competences and experience through collaboration. The term 'target price' reflects the means of payment for the contract, in which the aim is to achieve predictability with regard to the final value. This 'guarantee' is achieved by linking bonus payments and risk to an incentive scheme.

A number of collaborative contracts have been used since the early 90s in the civil and transport engineering industry, yet little research has been performed into it, perhaps because of the marginal number of contracts taking this form. The fact that the collaborative form and means of payment of such contracts more or less coincide with the number of contracts also means empirical research of various alliances tends to focus on specific problems, rather than principle evaluation.



[1] The contract for substructure work, including tunnel work, was a target price contract between Jernbaneverket (the National Rail Administration) and Veidekke AS.

**Administrators costs:**

$$E + G + (T - G)/2 + \text{Bonus} - \text{Mulkt}$$

$$E + (G + T)/2 + \text{Bonus} - \text{Mulkt}$$

**Contractors earnings:**

$$E + (T - G)/2 + \text{Bonus} - \text{Mulkt}$$

**Administrators gains:**

$$(T - G)/2$$

$T$  = target price = the means of payment for the contract  
eksl. earnings

$G$  = Grand total eksl. Earnings. Unit prices  $X$  measured  
quantities = grand total.

NTNU took part in the Nykirke passing track project, by producing an internal report on the work, which was used for the development of new forms of work for building and construction projects. The experience of NTNU was primarily linked to "SiB – Samspillet i Byggeprosessen" (collaboration in the building process) at that time [2]. Part 3 of this article in particular is based to some degree on the results of the NTNU report.

In the subsequent period, there has also been some focus on another form of partnering contract, called 'PPP projects'. Statens vegvesen (the Norwegian Public Roads Administration) has used this form of contract to a greater degree than Jernbaneverket within public transport [3]. The parameters of this article do not per-

mit further discussion of projects within Public Private Partnership (PPP) and Private Finance Initiative (PFI).

The offshore sector has also to a great extent given up the idea of developing collaborative contracts any further, with offshore and land-based industry preferring contracts based on modified principles we on land best know from engineering, procurement and construction contracts [4]. No attempts at standardising collaborative contracts have succeeded, and the partners will therefore stand to benefit from the use of a standard contract instead of a collaborative contract. However, there is an apparent need for modification of a purely standard contract between the parties in the form of special conditions on change management and payment [5].

The following is a report built on the Jernbaneverket's reference with the modernization of the railway track called Vestfoldbanen and specific reference to use of this form of contract in the Nykirke passing track project. The article also concentrates to a great degree on the substructure and tunnel contracts, and the examples will therefore relate to this specific contract area. Finally, thought will be given to the choice of contract form in the future. But firstly, I will take a look at some of the special framework terms applicable to Jernbaneverket's investment projects.

## THE PARAMETERS OF THE NATIONAL RAIL ADMINISTRATION

The National Rail Administration is an administrative body under Samferdselsdepartementet (the Ministry of Transport and Communications). On behalf of the government, the Administration runs, maintains and builds the national railway infrastructure. The Administration's customers and stakeholders in general are train operators and their personnel. The train operators' customers are potential rail travellers, other authorities (including inspection bodies etc.) employees of the Administration and suppliers/contractors and their personnel.

Other parameters the Administration works within are the National Transport Plan and the annual grants from Stortinget (the Norwegian parliament) with regard to speed of commissioning and implementation.

[2] Civil Engineer Ola Lædre, contributor Professor Tore I. Hagen: Internal Work Report from Pilot Project, NTNU Institutt for bygningsteknologi, Institutt for bygg- og anleggsteknikk, 2001 (Norwegian University of Science and Technology, Department of Structural Engineering, Department of Civil and Transport Engineering, 2001).

[3] See the report on three major PPP projects to the Public Roads Administration written for the Transportøkonomisk institutt (Institute of Transport Economics) by Dovre International, 2007.

[4] Olav Bergsaker: Commemorative volume for Norsk Forening for Bygge- og Entrepriserett, 2010 p. 171.

[5] L.c. pp 176 - 181.

When the need for an investment project is first defined, the project director appointed will collect background information to develop a contract strategy and procurement plan. The strategy will refer to the Administration's general supply and contract strategy and will have to take several aspects into account for the specific project.

In this context, it is relevant to define the parameters referred to above particularly with regard to grants.

In addition, other requirements from the authorities, laws and rules, public planning processes, other public sector projects which can affect the project, the supplier market, environmental aspects and relationships with neighbours and the surroundings all have to be taken into account, along with the actual location, other regards concerning health, safety and the environment, rail engineering, track availability, experience from similar projects, capacity etc.

## THE NYKIRKE PILOT PROJECT

### a) Background

The Administration has no long tradition of the use of alternative forms of contract. Normally, contracts are based on negotiated standard contracts such as NS 3431 and NS 8405. And to all practical intents and purposes, a traditional developer-controlled contract based on NS 8405 is used, with the form of payment just as traditional as the form of contract: fixed price, adjusted for adjustable elements. This was therefore a pilot project for a form of contract which transpired in connection with the building of the Nykirke passing track. In the summer of 2000, the Administration was given the go ahead to start the Nykirke project, but on the condition that it had to be kept within a budget of NOK 120 million. To achieve this, it was apparent that a target price contract may be able to provide sufficient surety for the project's budget because the substructure contract accounted for around 50% of the project costs.

Another major factor for use of the target price contract was the timeframe available to the Administration. From being given the green light to the fixed completion date, maximum use had to be made of the know-how and ideas of all the organisations involved. More details on this under letter d).

### b) Objectives

The effect objectives of the Nykirke project were:

- Improvement of capacity and/or punctuality on the Vestfoldbanen.

- Adaptation of the initiative for subsequent building of a double track line on Vestfoldbanen

The objectives of the target price contract with Veidekke were:

- Better collaboration
- Better solutions
- Lower costs

### c) Results

In terms of achieving the effect objectives, the project succeeded to a large degree and the same can be said of the target price contract. One of the project participants has effectively summed up the central lessons learned from the project:

*"The most important experience gained is that we spend our time constructively on solving problems."*

The effect of the contractor being responsible for hiring consultants was to a large extent already removed during the call for tenders. "The tight budget was based on optimum operation of the track, and the target price may have been set unrealistically low." [6]

A common feature of other collaborative contracts is to select the alliance first based on a provisional target price, and then build the group with the developer to make maximum use of good collaboration in the planning phase. This particular project used a form of technical and written exchange of experience through the pilot project, via tendering for a target price contract. During the implementation phase, the project bore the hallmarks of a traditional engineering, procurement and construction project, with particular focus on teambuilding across the various organisations involved.

Should the Administration continue to use this form of contract, a lot of consideration will be given to extending the period allowed for joint planning. It may also be possible that consultants and the architect group will not come under the contractor, but will be an equal partner in the alliance. Naturally, there will be a need to spread risk and bonus based on financial input from each organisation, but some collaborative contracts have found this form of partnership organisation to yield positive results.

Other experiences worth noting are the importance of clear boundaries in terms of remuneration in the form of volume adjustment or hourly-based payment. In parts

[6] NTNU report (see note 2), p. 30. The report also pointed out achievement of objectives in the project could also have been measured on factors other than price.

of the contract, volumes were adjusted, whilst others were invoiced by the hour. It showed that poorly defined lines in these areas can lead to discussions which reverse the benefits of collaboration and this also applied to a certain degree to the use of rounding-up items.

We have listed the special aspects which affected project completion, and which we believe we can make use of in later projects.

### POSITIVE

- The target price form of contract made a positive contribution to the project team, as the process was based on collaboration and empathy.
- Good accommodation due to sharing with the contractor.
- Good working environment and team spirit.
- Clear, common goals, which everyone in the project shared and owned.
- A lot of focus on satisfied customers, partners and neighbours.
- The project personnel at all levels were given responsibility by their superiors.
- Good management of progress and finances.
- Good mix of professional skills amongst the project personnel.
- Skilled and solution-oriented contractors.
- The contractor's idea of vertical draining of the bed made construction cheaper.
- Informal contact between the partners (see 'negative' also).
- Effective meetings
- The final cost of the target price contract was no higher than the target price. But if it had been a traditional performance contract, it would have been significantly higher.

### NEGATIVE

- Lower degree of expectation definition in the outer circle compared to the inner. The inner circle was defined to be:
  - a. PM (developer)
  - b. BM (developer)
  - c. Engineering Managers (developer)
  - d. PM (contractor)
  - e. Site Manager (contractor)
- Insufficient time allowed between contracting and construction work.
- Insufficient grants led to suspension of work.
- Slow decision-making process, particularly from the developer
- Consultant spent insufficient time on site.
- Informal contact between the partners (see 'positive' also). If a parallel track had been used with notification

in the system, some of the increased costs could have been avoided.

As can be seen from the above, the positives outweighed the negatives from target cost price contracting. A lot of potential was also identified for optimising this type of contract and project organisation.

### Implementation

The form of payment for this collaborative contract was based on volumes and hours. Unit prices and hourly rates were net cost price for the contractor and the contract regulated his profit.

The Administration ran a prequalification round for the competition for the substructure contract on the Nykirke passing track. There were four vendors qualified, and after the information meeting, all were supplied with a complete building plan. This was to be used to help them calculate the target price for the contract, and they were free to choose any solutions, without being bound to use those suggested in the developer's building plan. Criteria were set for function and quality.

The contractor who won the competition had put a lot of work into pricing and it was clear that in this phase of the competition, a lot of effort had been made by the contractors to find alternative and cost-saving measures. This resulted in the contractor being able to provide the function and quality required by the developer with alternative ideas. The building plan envisaged concrete piles in an area with very soft ground (clay) where the track crossed a stream on a 20 metre high embankment. There was also a distance of around 20 metres down to the existing ground under the soft embankment material.

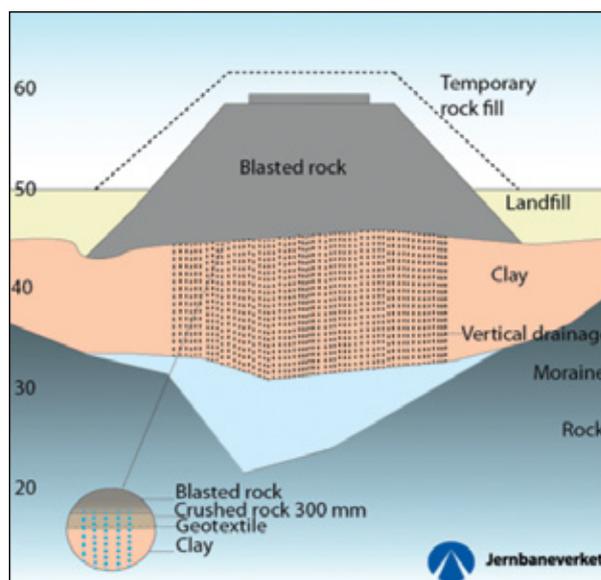


Figure 1 Building the Administrators solution to filling the affected concrete piles to bedrock.

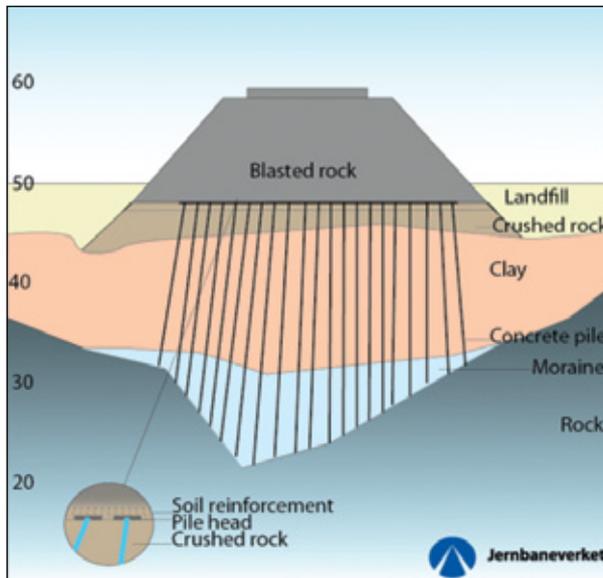
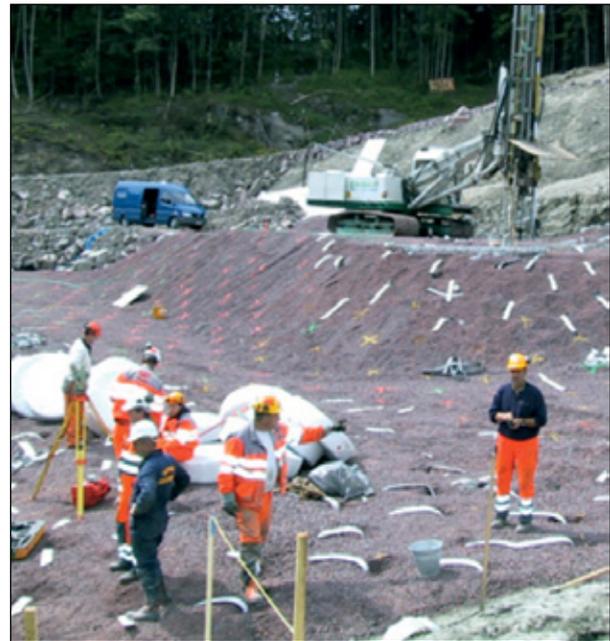


Figure 2 Veidekke solution with vertical drainage combined with temporary rock fill.



The winning contractor came up with a cost-saving method which involved using ‘vertical draining’. However, using the method required laying a primary rock fill layer which had to settle for around 5 months, during which it settled approximately 60 cm. The total length of vertical draining comprised 30,000 metres and the stone backfill comprised 71,000 m<sup>3</sup> including around 12,000 m<sup>3</sup> for the “ballast” (top layer). This method yielded a saving of several million kroner. Given the circumstances, the Administration does not believe that another form of contract or collaborative partnership could have given a better result in the pre-qualification and selection phase for target price, but hypothetically, if there had been more time for both phases before the target price was set, other solutions could have been found.

Once the contract was selected, building on site was given an early start. As can be seen from the list above, the time was considered to be far from optimal. Sufficient time for planning and collaboration in the planning phase is important for a variety of reasons, including the following two: firstly, collaboration in the planning phase will contribute to just that - collaboration. This will be achieved by the various parties getting together to exploit each other’s know-how in a forum

which stimulates innovation and progressive development with regard to technical solutions and factors which influence progress. Secondly, a climate will be created which lays down the foundations for collaboration for the project personnel working for the parties involved, simply because others have gone before. As stated under ‘experiences’, it is important to involve all personnel, and not just the inner circle of managers, something which was done in the Nykirke project by holding a joint kick-off on neutral ground.

During the implementation phase, a number of measures were also introduced to promote collaboration, including shared site accommodation. This made meetings easy, but also caused problems with regard to formalities and it became important to define rules for making contractual or technical decisions to avoid essential decisions being based on informal chat over lunch. The close and ongoing communication which developed was recorded in meeting minutes and meeting frequency was geared to meet actual needs. The contractor pointed out the importance of having authorised and responsible personnel empowered to make decisions out on the site. Another less positive aspect of the informal climate was that the Administration did not receive sufficient formal notice of changes in the contractor production plan.



Good examples of technical aspects which were changed and which can be traced back to the form of contract in this context include changing the course of Tangenbekken (the name on the stream) in a 120 metre long corrugated steel pipe with a 2000 mm diameter. The pipe took the stream under the 20 metre high railway embankment and the maximum settling has later been measured to 12 cm.

The contractor also decided on water and frost protection in the elevated section running out onto the “hengen” (shoulder), where it could run frost-free down into the drain. This solution - instead of water and frost protection of the entire profile - yielded significant savings for the project shared between the contractor and the Administration in accordance with the shares agreed in the contract. The experience and lessons learned can be employed in other tunnel projects where the tunnel length and thus the savings could be much higher.

During the tender calculation phase, the tenderers were encouraged to submit proposals for alternative methods for implementation and cost-saving processes. The winning contractor was far as the only one to meet and take this challenge.

## CONTRACT FORMS FURTHER DOWN THE LINE

As mentioned earlier, Jernbaneverket receives an annual grant from parliament, which affects the rate of commissioning and implementation.

So far, the lack of predictability with regard to the annual grants for investment projects has been a major controlling factor for the awarding of contracts, and it could well be that projects have been inappropriately allocated. However, there is broad expectation from society and promises from the authorities which in positive terms indicate future investment in the rail-

ways. This could lead to a greater degree of predictability, which in turn can have an affect on allocation and choice of contract form for future contracts.

For example: the future Follo – Ski construction project, where plans have already been approved for what will be the longest double track railway tunnels in Europe. What the final strategy will be with regard to form of contract for this project has not been finalised yet, but it is not unlikely that the framework of the project - given that it is already itemised in the national budget - could influence the choice of contract form.

As a major developer, we have a responsibility for - and want to see - the development of a contractor market within tunnels and substructures. The Administration will also benefit from the expertise and experience of such contractors and together with the industry, we can develop and increase our joint competence. This may be an over-simplification, but the need to raise the level of competence for modern rail and transport engineering workers is there. We cannot take it for granted that everyone will be satisfied with ‘just digging’, as most people want to think that as individuals, they are part of a greater whole. We should no longer be thinking in terms of a worker as someone shovelling stone, but as someone who builds cathedrals.

Regardless of the form of contract, the Administration is determined to gain the benefit of flexible alliances between the planners, the implementers and the developers, and we welcome initiatives from the industry to develop and optimise integration and collaboration within all phases and aspects of implementation of investment projects. Given that we can achieve flexibility in the planning and implementation phases through new forms of contract, plus guaranteed costs, low risk and the other benefits referred to above, the National Rail Administration is prepared to consider the use of collaborative contracts.



*The crew at face. Charging of another round is finished. Photo Ruth Haug, LNS.*

## 09. THE CONSULTANT'S CONTRIBUTION IN A TUNNEL CONTRACT

ARNESEN, Frode

### INTRODUCTION

A consultant can be hired to perform a multitude of tasks. This article focuses on experiences as a consulting and engineering company developing contracts for civil and rock works for construction of tunnels and caverns. The contract for consultancy can be very detailed specifying each task and the requirements for drawings and documents as well as services before, during and after construction. These contracts are normally developed by clients who have long and repeated experiences from projects, and have considerable experience and capacities within their organization. A variety of contract gives a general responsibility to the consultant to develop what is necessary for the project.

### A "NORMAL" LIFE CYCLE OF A TUNNELING CONSULTING ASSIGNMENT

To explain a consultant's contribution in a tunnel contract it is important to understand that a consulting assignment normally covers more than the construction phase. Below it outlined a short description of tasks during the different stages of a project, and a brief characterization of work performed. The assignment may include one, several or all activities.

Phase	Typical Product	Main Interfaces
1. Concept	Meetings, reports, drawings	Client and other consultants
2. Basic design	Reports, calculations and drawings, quantity and cost estimates, schedule	Client and other consultants
3. Applications and approvals	Impact analysis, descriptions, applications	Client, authorities, other consultants and experts

4. Detail design	Input to contract, bill of quantity, calculations, specifications, procedures, drawings, quantity and cost estimates, schedule,	Client and other consultants
5. Bidding and contracting	Contractor qualification, issuing documents, controlling and bid evaluation reports	Client, contractors
6. Construction phase	Construction drawings, follow-up engineering, site queries, drawing and specification of changes. Claims evaluations and quantity control.	Client, contractor, authorities
7. Completions	Quality control report, As-built drawings and documentation	Client, contractor
8. Guarantee period	Quality checks, deformations, leakages, rockfalls, rectification work reports.	Client, contractor, users

Plan and execute controls and checks during the guarantee period as well as check of issues concerning deformation leakages, rock falls or other issues during operation.

## **CONTRIBUTIONS TO THE TUNNEL CONTRACT**

The Norwegian civil contract code NS3420 and the road construction code (vegprosesskoden) are comprehensive documents developed as a key part of a Norwegian construction contract framework. National and European standards for engineering and drawings are additional directives and tools which shall be used by a consultant.

Below is mentioned some key comments regarding contract documents normally handled by a tunnel engineering consultant. More detailed information and guidelines are accessible in the English version of NS 3420 [1]

### **GENERAL INFORMATION**

This chapter gives information concerning the work locations and the rules and regulations concerning the project, often a result of the planning process prior to the contract. The quality and accuracy of this is vital and errors can have severe consequences.

Critical items can be:

- Location and accessibility of work and rigging area, Battery limits.
- Valid authority permits and their content
- Contractors responsibility regarding permits
- Project specific environment rules and regulations

These elements can be critical and must be evaluated and checked by the consultant and the client. Changes after contract award can be costly.

### **BID CRITERIA DEVELOPMENT**

Criteria for choice of contractors for the bidding round are important, as well as procedure and award criteria for the bid award should be decided at an early stage. This policy can have major importance for the content of the bid document. All information pertaining to this should be clarified and defined.

### **SITE INVESTIGATIONS AND GEOLOGICAL CONDITIONS**

Reports documenting ground conditions and geological data are essential for a tunnel contract. As unforeseen, or undocumented changes or challenges in ground conditions according to Norwegian practice often must be compensated by the client, correct and precise descriptions is vital for project cost and schedule control. This is a major task for engineering geology consultants.

### **SPECIAL PROCEDURES AND SPECIFICATIONS**

Special procedures or processes which are identified as

necessary for the project, but not covered as part of the standard, must be described and specified. When the contract code NS3420 is used it is important that correct detail specification and information is added to each specific item description.

### **DRAWINGS**

Drawing accuracy and coherence is a major responsibility. It must be underlined that the constructability of what is shown on the drawings also is important. Checking of critical parts by persons with practical experiences from same or similar construction methods and tolerance requirements is essential.

### **BILL OF QUANTITIES**

The contract after Norwegian construction contract practice is a mix of fixed sums and unit prices. The unit prices are consumables or items compensated after compensation verified by the client's representative. When a contract is edited it is important to note that the client and the contractor can have opposing strategies when the quantities are set in the bidding process. The consultant's role in this process is to give his best assessments of the quantities and work out the bill of quantities in close cooperation with the client.

### **HANDLING OF VARIATIONS AND UNCERTAINTIES**

If areas of uncertainties or a high level variance of quantities is identified, special rules for ordering additions, regulation formulas for fixed sums or risk shearing rules can be added. This can be a complex area, and advice from contract specialists, or legal advice can be necessary.

### **FINISH DATES AND PENALTIES**

Definitions regarding finish dates, acceptable delay causes and penalties are often covered by the contract codes. However, if the client has critical dependencies or important milestones which must be met, it is important to address and work out effective penalty regulations and if possible rewards to ensure a successful result. This does not replace developing a realistic work schedule at an earlier stage.

### **BID EVALUATION**

When the bids are received the consultant might be responsible for checking of correct pricing, and checking the method statement. The bid can have alternative offerings which need checking and consequence analysis. The consultant can also participate if other criteria than economical value is to be considered for contract award. A evaluation scheme should be worked out as part of the contract document. To avoid possibilities

for bias or corruption many client handles bids in a separate department with none or limited contact with the consultant.

### **FOLLOW UP ENGINEERING**

Follow –up engineering can be performed by the consultant as an integrated part of the construction team or as site visits or planned checks as specified by the contractor.

### **GEOLOGICAL MAPPING AND ROCK SUPPORT.**

In Norway rock stabilization during the work phase is basically the responsibility for the contractor, in most contracts, however there is an obligation for the contractor to co-operate with the client in such a manner that rock support installed during the work phase can be combined with rock support for long term or permanent phase.

In order to do this the client, or his representative have to have access to the rock for mapping and sampling before it is sealed by sprayed as well as full information of the stabilization work performed by the contractor. In some tunnel project it is an goal that all support work shall be performed close to the face, and according to the clients design parameters. This requires client and contractor to jointly decide rock support method and quantity, as the contractor still has the primary responsible for the safety of the work crew.

This work and decision model establishes a transparency of information between client, contractor and consultant regarding rock conditions, work performance and use of materials contract. It is possible to resolve conflict based on real values and avoiding suspicion with regard to the facts as all parties are present. In a

contract there will still be issues to disagree upon even if all facts are known to all.

### **OTHER TASKS FOR THE CONSULTANTS**

- Work out and issue construction drawings
- Handle site queries
- Participate in clients work on quality and HSE.
- Checking quantity and quality of performed work including documentation data and documentation.

### **CONTRACT CLOSEOUT**

The consultant has a major role in collecting, filing and/ or checking all as-built-data and if required prepare As-built drawings for the future use by the client. For the final economical closeout of the contract checking quantities and pricing in the final cost setup.

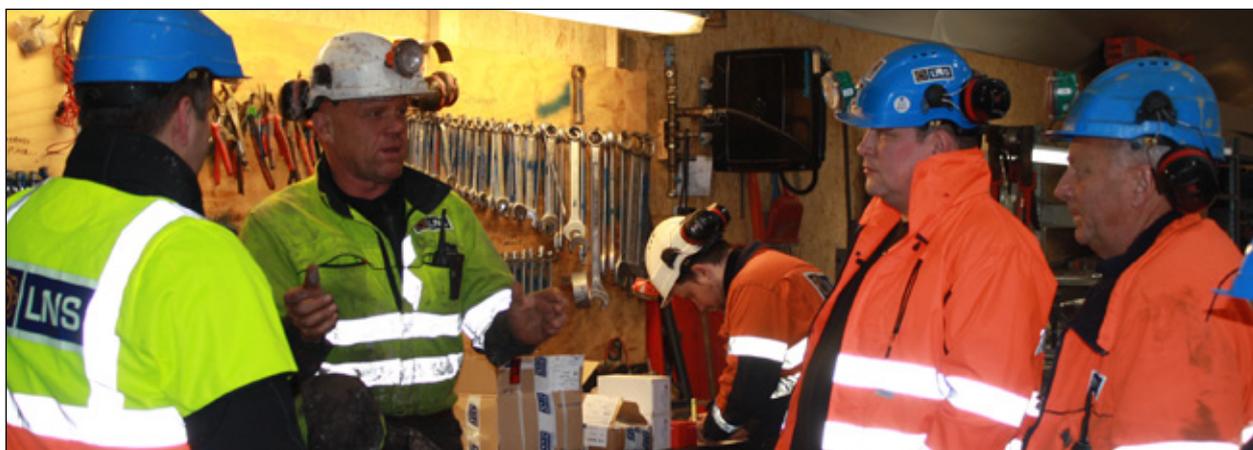
Resource usage in different project phases.

For a complete tunnel contract have following typical distribution of hours used:

<b>Phase</b>	<b>Man-hour percentage</b>
Concept phase :	3
Basic design:	10
Applications and assessments:	10
Detail design:	30
Contracting2%	2
Follow up engineering 40%	40
Completion 5%	5

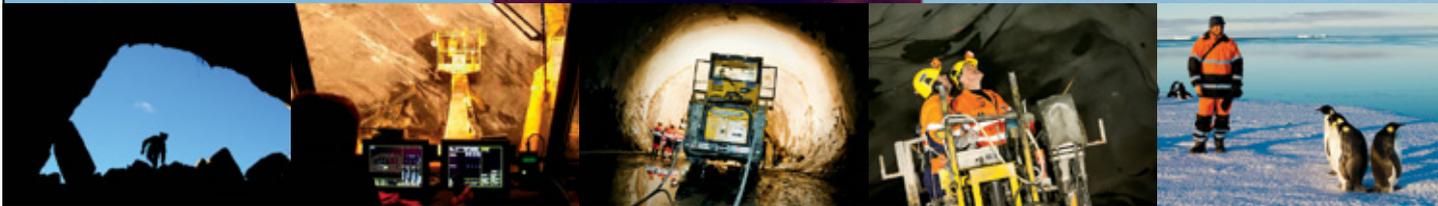
### **FUTURE TRENDS AND DEVELOPMENTS**

Computerized systems for 3d drawing and documentation give new possibilities for complete accurate documentation. Increased complexity of projects and systematic usage of quality control systems increase time used in meetings and workgroups. The quality and quantity of drawings and documentations is improving. The resource usage of consultants on projects is expected to increase.



*Technical discussion in a workshop at site. Photo Ruth Haug, LNS.*

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**We are raised beyond the arctic circle. We are raised to work hard.  
We are raised to make more of less.**

Our secret and success are recognized by strong and competent teams, advanced equipment, efficiency and quality.

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## 10. NORWEGIAN CONTRACT PRACTICE SUITABLE ALSO FOR DEALING WITH UNEXPECTED GEOLOGICAL CONDITIONS. THREE PROJECT EXAMPLES.

GRØV, Eivind

### INTRODUCTION

This paper presents three cases of subsea road tunnels that cast light on the suitability of different types of contracts. Firstly, the 3.8km Godøy tunnel (the deepest subsea road tunnel in the world at the time) where a grouting effort much larger than planned was needed to prevent unexpected and unacceptable water inflow. The unit price contract proved to be suitable even with a more than 3 times increased quantity of grouting. Secondly, the 2.0km Bjørøy tunnel was expected to be a straightforward project suitable for a fixed price contract. An exceptional occurrence of a sand zone caused serious delays and cost overruns, resulting in litigation. The contractor had to take the loss. It is discussed whether a unit price contract would have been more suitable in this case. Finally, the Oslofjord tunnel is discussed. During construction an unexpected erosion channel filled with soil was detected by probe drilling at the tunnel's deepest point, i.e. under 120m water pressure. The necessary measures were dealt with outside the unit price contract regulations.

The experience shows that unit price contracts are suitable to deal with 'unexpected geological conditions', as long as the 'unexpected' element results only in variations in the quantities of work activities. This means that all necessary work activities must have quantities and preferably also 'standard capacities' for regulation of the construction time. In fact, variations in quantities must be expected in any underground project, and such variations therefore hardly deserve the term 'unexpected'. If unexpected conditions occur in the form of unforeseen geological features necessitating work activities not included in the Bill of Quantity, the unit price contract must be supplemented by special agreement, usually some form of cost reimbursement. Fixed price contracts for underground projects, may not provide the intended predictable cost. Modified or 'adjustable fixed price' contracts, combining elements from both unit price and fixed price contracts, may prove to be more suitable than fully fixed price contracts.

Requirements needed to establish suitable tunnelling contracts and the need for project specific and balanced allocation of risks are outlined.

### UNPREDICTABLE WORK CONDITIONS CALLS FOR FLEXIBLE CONTRACT PROVISIONS.

Norway forms part of a Precambrian shield. Two thirds of the country is covered by Precambrian rocks (older than 600 million years), with different types of gneiss dominating. Other rock types from this era are granites, gabbros and quartzite. Approximately one third of the country is covered by rocks of Cambrian - Silurian age. The greater part of these rocks are metamorphosed, but to a varying degree. Rock types such as gneisses, mica-schists and greenstones as well as sandstones, shales, limestone and other unmetamorphosed rocks form a mountain range, which runs through the central parts of the country. In the geologically unique Oslo region, the rock mass is partly made up of unmetamorphic Cambro-Silurian shales and limestones and partly of Permian intrusive and extrusive rocks. These are the youngest rocks.

The geological setting is dominated by igneous rock types together with metamorphic rocks of various types and origins. The host rock is more or less intersected by weak zones, which may have an intense tectonic jointing, hydro-thermal alteration, or be faulted and sheared, constituting significant weaknesses in the rock and making the rock mass far from homogenous. These conditions will frequently call for grouting to reach a desired low level of rock mass permeability

The zones of weakness can exhibit great variation in quality, their Q-classification ranging from "extremely poor" rock mass at the lower end of the scale, to "good", with width extending from only a few centimetres to tens of metres.

The hydrogeological situation is dominated by high groundwater level, also in the rock mass. This situation is both favourable and unfavourable for rock tunnelling. One advantage of a groundwater regime surrounding an underground structure is that it provides a natural gradient acting towards the opening allowing the utilisation of unlined storage facilities. On the other hand, one

disadvantage of such saturated conditions is the risk that the tunnelling activity may disturb the groundwater situation, thus imposing the potential of adverse impact on surface structures and biotypes.

Taking into account that “mother nature” has produced a material that is far from a perfect material, and that the rock mass may have a set of imperfections, it is most common that the construction process involves various techniques and methods to assist the design of a construction material that suits its purpose. Hard rock includes a wide variety of rock mass qualities, from competent rock mass in one end of the scale to totally disintegrated and exceptionally poor rock in the other acting merely as a soil, the latter being typically associated with weakness zones. Such weakness zones can be faults with crushed material that may be more or less altered to clay, and could be several tens of meters wide calling for extraordinary measures and tunnelling methods. Swelling clay minerals is often found in such zones. Thus, it is clear that hard rock encompasses a lot more than straight forward tunnelling, and the challenge above all is to establish a tunnelling system that is capable of handling this varying construction material, still utilising its capacities where applicable. Discontinuities represent special challenges as regards stability and proper handling to ensure a safe and sound tunnelling process.

In this context the importance is obvious as far as having a contract concept and philosophy that enables this ever changing ground to be appropriately dealt with.

### **PARTICULAR RISKS ELEMENTS OF SUBSEA TUNNELS**

Characteristic risks of subsea tunnels are connected to:

- limited knowledge about ground conditions due to practical difficulties and higher costs for site investigations prior to construction;
- rock quality in fault zones etc, typically occurring on the deepest points with the least rock overburden;
- the inherent hazard of tunnelling below the sea, with an inexhaustible supply of water should a collapse of the overburden occur.

For tunnelling on land, many of the practical problems involved are of a similar nature, although the risk profile may be lower.

### **CASE STORIES TO DEMONSTRATE CONTRACT DETAILS**

Table 1 presents an overview of the main data for the project cases that are discussed. All were excavated as one tube tunnels (for 2 or 3 lanes) by drilling and blasting. The subsea section of the tunnels varied from 26 to 39% of the total length.

As for site investigations, the procedures for excavation, rock support, probe drilling and pre-grouting follow the guidelines set by the Norwegian Public Roads Administration (Ref. 1, and as described in a number of publications (Ref 4). Accordingly, all tunnels were constructed emphasising systematic probe drilling and pre-grouting as needed ahead of the tunnel face. This includes typically 3-5 percussive probe holes of 30m length with min. 8m overlap (see Figure 1) and pre-grouting cone-shaped fans of 15-25m length (see Figure 2), which constitute the most effective risk reducing measures during construction. Table 3 presents expected and applied measures for rock support and ground treatment.

### **GODØY TUNNEL**

The Godøy tunnel on the west coast of Norway was built by the same private owner and contractor as the two Ålesund tunnels, which have been described in a number of publications<sup>5</sup>. The project was financed by private loans, without any guarantees from the government, to be repaid by the income from toll fees. The county contributed capitalised subsidies for the ferry that was replaced.

The geological conditions were well known, in particular considering the experience from the nearby Ålesund tunnels. Normal investigations without core drilling were performed. The owner had support from the local Public Roads Administration and experienced advisors<sup>6</sup>. The contract was a normal unit price contract with reimbursement according to tendered unit prices and regulation of construction time using the normal system of pre-set ‘standard capacities’.

During excavation, the rock mass quality proved to be as expected or even better with respect to stability. Table 3 shows that more rock bolts, but less sprayed concrete were used than the estimate. No cast-in-place concrete lining was necessary. However, a joint set with open character, striking NE-SW along the coast, required far more pre-grouting than expected. This was possibly due to relatively recent tectonic movements, resulting in joint apertures from 1-2mm up to 25-30mm. The actual grouting quantity was 3.2 times the tendered quantity with respect to dry weight and took almost 6 times longer time to produce. The phenomenon of open joints is foreseeable, but the needed extensive effort was not foreseen. The potential inflows were not related to rock cover or type or lack of soil overburden, in contrast to the Ålesund tunnels.

Despite the extensive pre-grouting needed, the tunnel was opened for traffic after 16 months construction,

Tunnel	Godøy	Bjørøy	Oslofjord
Year completed	1989	1996	2000
Main rock type	Gneiss	Gneiss	Gneiss
Cross section, m <sup>2</sup>	55	53	79
Total length, km	3.8	2.0	7.2
Subsea section, km, (%)	1.5 (39)	0.5 (26)	2.0 (28)
Lowest level below sea, m	155 1)	82	134
Min. rock cover, m	33	30	32 2)

1) World record for subsea road tunnels at the time

2) Except in eroded fault zone

Table 1: Main project data

Tunnel	Godøy		Bjørøy		Oslofjord	
	Expected	Resulting	Expected	Resulting	Expected	Resulting
Quantities						
Rock bolts, pc/m tunnel	2.5	5.9	4.1	2.8	3.9	3.6
Shotcrete, m <sup>3</sup> /m tunnel	0.9	0.35	1.1	1.3	1.2	1.6
Concrete % of tunnel	1.3	0	2.5	1.5	7.4	1.6
Percussion probe drilling, m/m tunnel	3.5	6.0	3.6	2.2	2.9	6.9
Core probe drilling, m/m tunnel	0	0	0	0.1	0.4	0.2
Grouting, kg/m tunnel	83	265	51	670	220	360 1)
Water inflow, l/min/km	300	260	300	400	300	220

1) 30% consumed in the eroded fault zone

Table 3: Rock support, probe drilling, grouting and water inflow

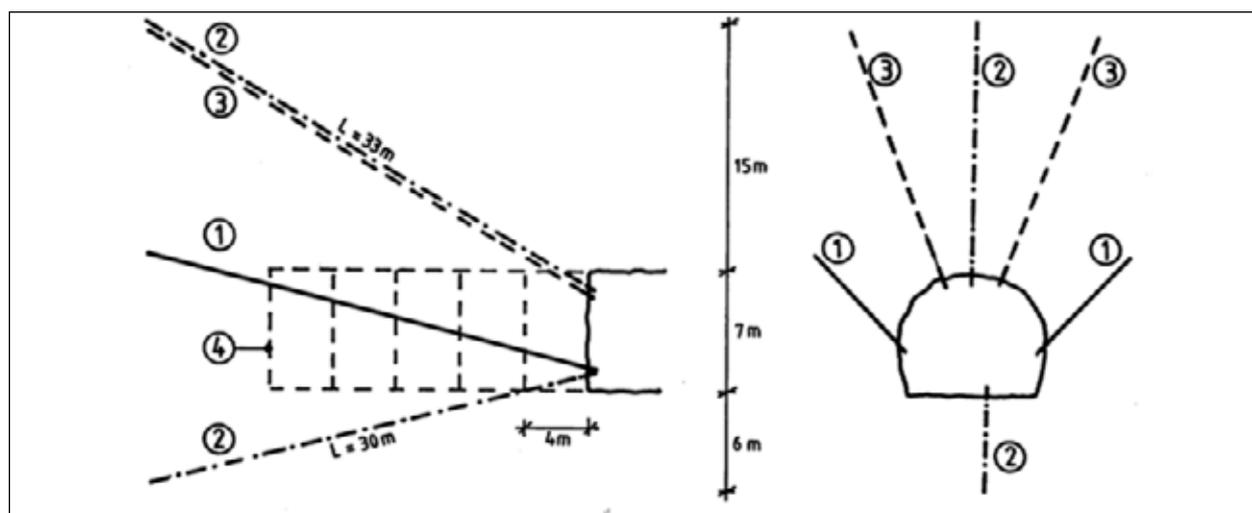


Fig. 1: Probe drilling pattern for the Godøy tunnel

(1) Probe holes at all tunnel sections below sea or loose deposits

(2) Additional holes where weak zones were expected from the seismic surveying

(3) Alternative upper holes in sections with rock cover less than 25m

(4) Min 8m overlap of probe holes drilled for each 5th blasting round

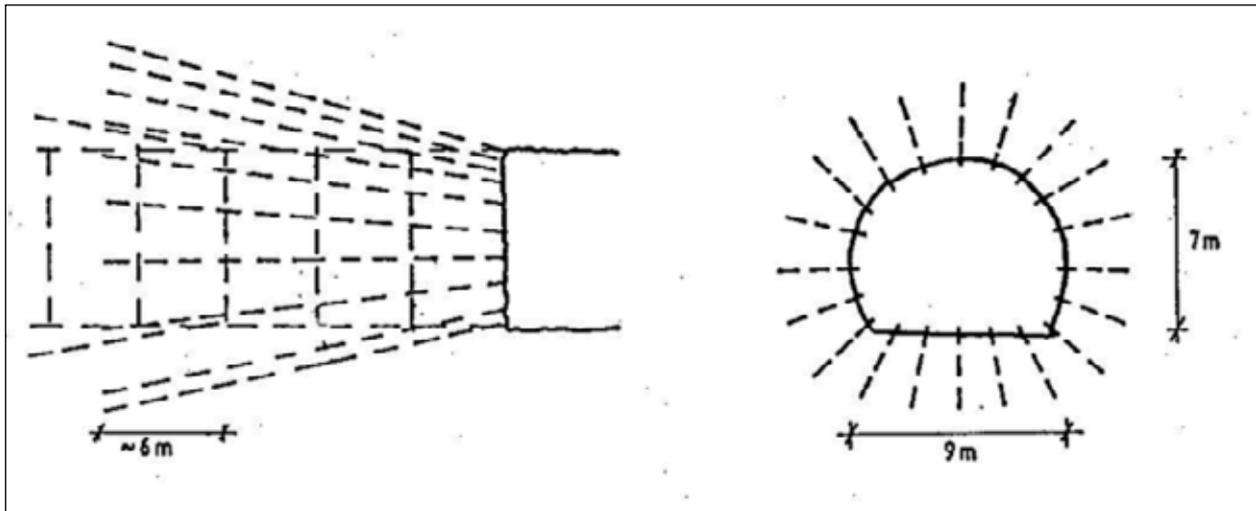


Fig. 2. Pre-grouting drill-holes for the Godøy tunnel, full cone of 18m long holes. Overlap usually minimum 6m

actually 5 months ahead of schedule. This was mainly due to the reduced time for rock support and the efficient approach to changing between excavation, stabilisation and grouting. According to contract regulations, the construction time was adjusted allowing for the increased grouting time. The grouting efforts increased the tunnel cost by approx. 5% compared to the estimate based on expected quantities.

It may or may not have been possible to determine the unusually open character of the joints by long directional core drilling prior to construction. The cost of 1-2 such holes could have reached 2-4% of the tunnel cost or more. Even if the especially open character of the joint set had been realised, this would only have changed the estimated quantity in the Bill of Quantity (BoQ). This could have resulted in somewhat lower unit prices, but would not have offset the increased site investigation costs. In this way, the extent of the site investigations was cost effective.

All necessary activities were covered by quantities and corresponding unit prices and 'standard capacities'. No conflict or litigation resulted. Thus, the contract worked according to intentions, i.e. the owner kept the basic risk for the geological conditions. This is typical for most of the subsea tunnels built in Norway so far.

### BJORØY TUNNEL

The Bjørøy tunnel is located on the west coast of Norway outside Bergen. Its purpose was to establish a fixed link between an archipelago of islands (with only 400 inhabitants) and the mainland. The plans were promoted by private initiative. There was no public financing available at the time, except by toll fees and the normal contribution from the county from capitalised ferry subsidies. This triggered the interest of one of the

large contractors, who already had extensive experience with subsea tunnels, and a proposal for a fixed price project was developed.

The local Public Roads Administration prepared the detailed design and managed the contract. Regarding the geological conditions, nothing unusual was expected by either party, except a relatively high level of conventional rock support measures, i.e. rock bolts and sprayed concrete. The Pre-Cambrian gneisses and the metamorphic rocks of the Caledonian mountain-range formation were known from many projects in the district.

The contract was designed as a fixed price contract as a result of the project circumstances. Political approval was given on the clear condition that no funding could be allocated from the regular 'queue' of scheduled public projects. Accordingly, the contract contained very specific clauses regarding risk allocation. The contract sum constituted the full reimbursement to the contractor, for excavation, rock support, grouting, other civil works and installations, including any variation in quantity or change of conditions. The owner should not be entitled to a cost reduction if the content of the works proved to be of less volume than expected. Only specific change orders from the owner would lead to adjustments of the contract sum, this could apply for example if a required change in standards emerged during the construction. It was also stated that the contractor had full responsibility for any further site investigations, and that all risks in connection to the ground conditions were his, including the rock cover. In contrast to the normal unit price contract, which keeps practically all risks for the ground conditions on the part of the owner, this contract allocated all risks for the ground conditions to the contractor.

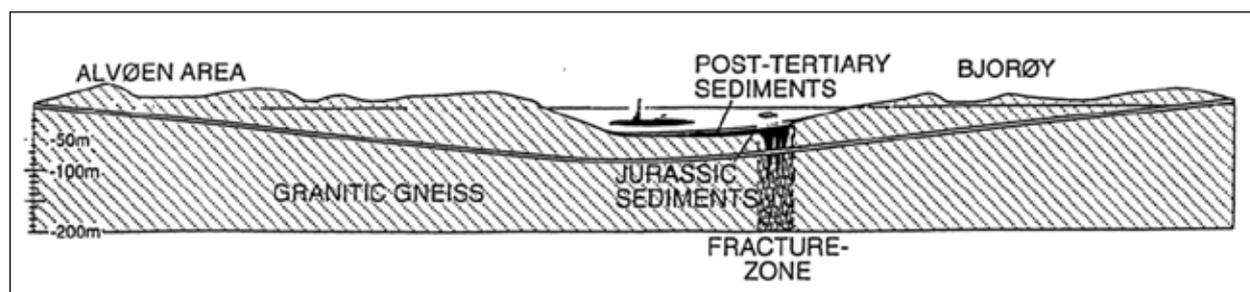


Fig. 3: Longitudinal section of the Bjorøy tunnel

During excavation, it was found that the rock mass was generally more jointed than anticipated, and a significantly increased pre-grouting became necessary. Conditions worsened, and the main problem occurred when the tunnel reached a fault zone between the Pre-Cambrian and the Caledonian units, see Figure 3. Here a zone of Jurassic sandstone and breccia occurred, partly completely disintegrated. This sub-vertical sheet-shaped zone intersected the tunnel at an angle of 30-35 degrees giving very poor conditions over a 45m section, with a 4m wide zone of completely loose sand under 80m water pressure. The fine grained sand mixed with water gushed under pressure out of the probe holes, unless they were blocked off (Ref. 7,8).

The contractor called in external advisors to form an 'expert group' to advice on a safe tunnelling method. After 3 months preparation, the zone was tunnelled through by applying a specially developed method, combining extensive pre-grouting with microcement for sealing and compaction as well as attempts to chemical penetration grouting. The excavation through the zone was done by short rounds and extensive use of fore-bolting ('spiling'). Technically this method was successful. The contractor completed the tunnel 10 months behind schedule, out of which about half may be directly allocated to the central sand-zone, the rest to the very poor ground adjacent to it. The contractor claimed additional reimbursement amounting to 60% of the fixed price for the adverse and unexpected ground conditions, which he characterised as 'extreme' and not compatible with the implied and applied method of 'rock tunnelling'. A settlement was not reached, and the case went to court. The first court level agreed with the contractor on basis of the exceptional ground conditions, as the two appointed co-judges with technical background voting down the professional judge. This verdict was appealed, and the next court level basically agreed with the owner (with the dissent of one of the two co-judges) primarily on the grounds that the contract was very specific about risk allocation, and that both parties were experienced.

The Jurassic zone, occurring in this area and in this

manner, was indeed unforeseen and was characterised by geologists as 'sensational'. Based on the geological interpretations, the occurrence may be considered as a rare case of 'unforeseeable' conditions. The exceptionally poor ground conditions might have been determined by long directional core holes, but this is not certain. Due to the overall confidence in the geological conditions, none of the parties wanted to pay for such investigations, which would have had a significant cost.

Paradoxically, the exceptional use of a fixed price contract coincided with the occurrence of exceptional ground conditions. A fixed price contract was applied due to the limited economic foundation following the small traffic base. If the tunnel had served a larger population, and public financing had been available, it is possible that a normal unit price contract would have been used. The generally poorer conditions would then have been handled routinely by the regulations for increased quantities. The exceptional sand-zone would likely have been taken out of contract and paid according to a special agreement. By this the owner, and the public through the toll fees, would have taken most of the extra cost.

As it was, the contract can be said to have worked according to intentions from the owner's point of view, but not from the contractor's, who took a heavy loss. Agreeing with the courts' verdicts or not, it appears to the authors that in hindsight the 'all-inclusive' risk allocation to the contractor was not suitable for this project. A less solid contractor might have gone bankrupt in the process and left the tunnel uncompleted. The owner would then have had two options: either to complete the tunnel at the expense of delaying other public projects or leave it uncompleted. The latter option might have been politically difficult. This demonstrates that in any case the owner is exposed to significant risks, although the fixed price contract was intended to minimise his exposure to risks.

### OSLOFJORD TUNNEL

The Oslofjord tunnel is located about 40km south of Oslo, linking the main highway system on each side

of the fjord. It was partly financed by the government, partly by capitalised ferry subsidies from the counties and partly by county guaranteed loans to be repaid by the toll income.

The tunnel passes through different kinds of gneisses and under the fjord it crosses three major fault zones along the N-S striking Oslo graben. The geological conditions were well known in general. In addition, extensive pre-construction site investigations were performed including directional core drilling through the western fault zone at tunnel elevation, see Table 2. This fault zone was the one expected to be worst; in Figure 4 it is marked as the 'Oslofjord zone'.

The owner (the local Public Road Administration) organised a project management team with experienced key staff and advisors to follow-up the construction. The contractor had extensive underground experience. The contract was a normal unit price contract with time regulation according to performed quantities.

During construction, less rock bolts were used than expected, more sprayed concrete (Ref. 9), but significantly less cast-in-place concrete lining, see Table 3. As tunnelling advanced from land out below the sea, percussive probe drilling ahead of the face revealed that the expected major fault zone on the western side of the fjord had been eroded to an un-expected depth. This included a section of 30m found not to be passable by normal open face excavation, as it contained loose soil deposits under 120m water pressure. The tunnelling had started from a steep access tunnel close to shore (below Hurum, see Figure 4); the purpose of this access was to deal with potential problems in this fault zone early in the project time schedule.

Preparatory grouting followed by ground freezing was considered to be the best method to enable safe passing of the zone. The technical handling of the zone was done in full co-operation by the parties, supported by external advisers in a 'task force' (Ref. 10). The freezing took a longer time than anticipated at first, but the tunnel was completed on schedule because the zone was encountered at an early stage of the project.

The geological conditions as encountered and the methodology applied in the 'freezing zone' were acknowledged as being outside the scope of the contract. A special agreement was made for the bypassing of the zone with a deeper lying temporary transport tunnel. It was later possible to utilize this by-pass as the pumping buffer reservoir, replacing the designed reservoir.

The unit price contract was not intended to cover such conditions, as the depth of the deep erosion was not foreseen in spite of extensive site investigations. Freezing was not included in the BoQ. The phenomenon of deep erosion was indeed foreseeable, and was the very reason for targeted investigations. Still, the interpretations proved to be inaccurate. In retrospect, the extent of site investigations prior to construction was sufficient, but the directional core drilling should have been targeted above the tunnel alignment in order to verify the rock cover.

It was demonstrated that it is possible for experienced parties to make an agreement outside the contract to deal with such unforeseen circumstances. However, after the successful technical completion, litigation still followed. This was due to disagreement about the payment for crossing the zone and extra costs for the transport through the by-pass tunnel. The cost increase, which remains to be finally settled, is in the order of

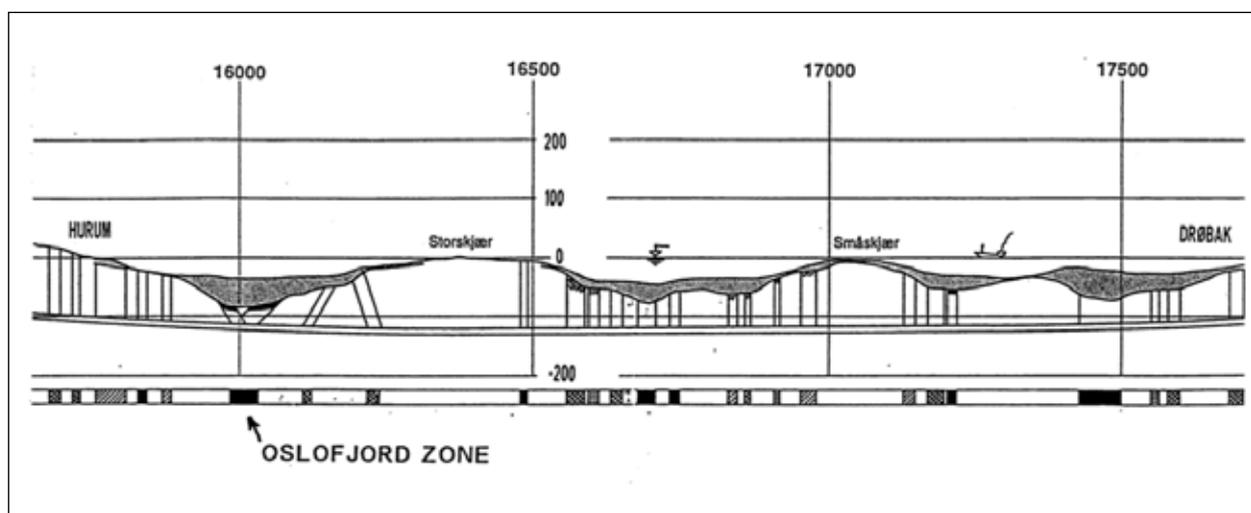


Fig. 4: Weakness zones at the Oslofjord tunnel, looking north. The 'Oslofjord zone' proved to be deeply eroded

10-20% of the expected tunnel cost. The actual costs related to the litigation itself were significant. The verdict criticised the parties for not trying harder to settle the economic aspects out of court.

### LESSONS LEARNED

From the above case stories, these lessons may apply to other tunnelling as well:

- Independent of the type of contract, it is important not to become too confident about the results or rather the interpretations from the site investigations prior to construction. It is necessary to rely on relevant and sufficient site investigations, still maintaining the respect for the potential variations of nature, both regarding variations of foreseen features, but also regarding the unforeseeable, the features that nobody expects. The systematic use of an independent project review, by a party not identifying itself with the project, is advisable.
- In unit price contracts, which normally allocate all or most of the risk for the ground conditions to the owner, it is easy to deal with large variations of quantities in a fair manner, as regulation mechanisms are built into the contract. If unforeseen features occur, for which there are no methods and quantities available in the contract, separate agreements need to be established, and cost reimbursement may be suitable.
- Fixed price contracts, with all risk for ground conditions allocated to the contractor, may have an apparent predictability of cost, which may be attractive to the owner. However, this type of contract imposes risks on the contractor that may at best be difficult to quantify, at worst disastrous if the unforeseen or unforeseeable occurs. Such risks may become the owners problem, no matter the contract text, e.g. if the contractor is not able to bear the loss and complete the project.

### SOME REMARKS ON THE CHOSEN EXAMPLES

Unfortunate incidents in Norway proving that rock fall accidents and tunnel collapses may also happen in tunnels opened to traffic. This has forced the industry to review the Norwegian tunnelling concept. Some modifications have been enforced, but basically the industry sticks to proven tunnelling philosophy. An effect the review has had, is improving the specification to set apart time in each drill and blast cycle to do the necessary geological registrations, so it is known exactly what is behind the visible surface before it is covered with concrete, water and frost insulation, fire insulation etc. Another modification is classifying the rock mass in order to prescribed rock support measures designed and verified to be sufficient in the actual cases.

The Norwegian Public Roads Administration and other main tunnel owners have used the drill and blast method for Norwegian tunnels for many years, and are confident with the method. The drill and blast method has proven effective in the hard rock environment. It is a flexible method, allowing changes in the tunnel shape or diameter easily, and giving unrestricted access to the tunnel face which is a useful facility to be able to deal with changing ground conditions. The use of TBM method was typically applied for the hydro power development and only in a couple of instances in the 1980'ies for road tunnels. Conventional drill and blast is likely to continue to dominate road tunnelling in Norway, whilst the Norwegian Railway authorities is currently viewing TBM as an alternative for some of their future tunnel projects.

Keeping in the mind the amount of tunnel projects being executed in Norway every year the number of cases that requires court decision is few indicates that the risk sharing principle work well in Norway. In spite of being a high cost area tunnel prices are favourably low.

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Charging in progress. Photo Ruth Haug, LNS.

## II. PROJECT INTEGRATED MEDIATION (PRIME)

KAASEN, Knut

### PROJECT CONFLICTS

One will have to search long and hard before finding anyone in the construction industry who has worked on a major project in which the parties, at all stages, were in harmonious agreement on the facts and the law associated with the terms of the contract. This is not surprising considering the many issues of facts and law involved in such projects – and the importance they have for the commercial aspects of the project.

But though disagreements and disputes are as old as project life itself, the methods for handling such common occurrences are not as static. The objective of the following is to look at a relatively new variant used in Norway: PRIME – Project Integrated Mediation [7]. The key here is not to wait until a dispute has matured to summon the assistance of a third party, but to involve a third party from the start of the contractual work.

A distinction can be made between conflicts that arise during the course of a project, that is to say, prior to completion, and those associated with the settling of the final account. In both situations, the fundamental legal question is: Who carries the time and cost risk of what is happening or not happening now, or what should already have happened or not happened? And in both situations the parties must deal with a delightful mix of law and facts in an ill-fated spiral of a decidedly hermeneutic nature [8].

However, the final account discussion has in addition some particular characteristics: Claims from the entire project period are gathered for collective review, during which they are considered in the sharp,

but at times also quite unrealistic light of hindsight. The major issues are no longer the isolated consequences of delayed drawings, unmanageable ground conditions and mediocre productivity, but the collective consequences of an interaction between factors which, even individually, may be difficult to deal with. The key words are “productivity disturbances”, breach of conditions, exceeded rate limits and other terms which, for many, conjure up images of numerous binders full of documentation, dismal progress reports and thoughtful graphical presentations of selected parameters.

Such exercises in “reconstructing the project” to justify or reject claims are risky. It becomes a game involving an unclear evidentiary situation, huge figures and a strong element of discretionary judgement, in addition to the uncertainty inherent in contract law itself. Although the parties to an individual dispute may typically have a different tactically based view of the desirability of embarking on this game, there is no doubt that usually they would both prefer to be spared the trouble. Project life becomes so miserable when it is discovered that this is the way things are headed. The atmosphere becomes acrimonious, and constructive cooperation degenerates into distrust and the one-sided safeguarding of interests. But more important than the mood is the result, which is often that the project solutions are suboptimal.

### HOW CAN PROJECT CONFLICTS BE HANDLED?

Put simply, there are three ways of dealing with project disputes: prevent them, resolve them or ignore them.

[7] I am not aware of this term having been used before I used it in a commemorative volume for the Norwegian Association for Building and Construction Law, *På rett grunn – festskrift for Norsk Forening for Bygge- og Entrepriserett, Oslo 2010* (see page 286). It is, I hope, fairly self-explanatory, but it will be discussed in more detail in what follows.

[8] “The hermeneutic circle means that in order to understand something with meaning (a text, a story, an image, an action) we must, in the interpretation of the individual parts, always start from a certain “pre-understanding” of the whole to which the parts belong. Our understanding of the parts thus attained is then impacting our understanding of the whole etc.” (Store Norske Leksikon: *Den hermeneutiske sirkel*: <http://www.sn.no/hermeneutikk>, translated from Norwegian).

Few would recommend the last-mentioned approach: problems do not disappear by being ignored – they multiply [9]. On the other hand, both prevention and resolution present many variants.

One of the classical tools for preventing disputes is first and foremost to improve the contractual basis. We will not look at this tool in any depth here. However precisely the contract is worded, however balanced and dynamic it is and however effective the implementation of the interaction between contractual basis, price format and project organisation, it will of course not be sufficient to avert all conflicts. It is simply not possible to regulate and organise away from all disagreement. And even if it were possible, situations might nevertheless arise where one party refuses to observe clear contractual commitments quite simply because he sees the consequences as unreasonable or unmanageable.

Thus, conflicts will arise, and as there is little to be gained by ignoring them, they must be resolved in some way or other. In principle this may be done in four ways: the parties manage to find a solution themselves, “power prevails”, a third party assists or a third party decides.

We shall not look at the first two solutions, but we will look briefly at the two solution models that are characterised by the bringing in of a third party. As useful background for the discussion of PRIME, let us start with the most dramatic form: A third party decides.

## CHARACTERISTICS OF ARBITRATION AND LITIGATION

There are two different ways in which a third party may be given decisive authority in a parties’ dispute: the parties may turn to the ordinary courts or they may agree to submit themselves to the decision of a privately appointed body. If this decision is to have executory force, the rules of arbitration must be followed [10].

In both cases, the decision will normally be based on

rules of law, [11] and the process leading up to the decision will follow the basic civil procedural requirements [12]. However, there are – in our context – important differences between a hearing before the courts and a hearing before an arbitral tribunal.

The basic difference arises from the fact that an arbitral award normally may not be reviewed [13]. As arbitration therefore becomes “the Supreme Court in the first instance” the parties are urged to leave no stone unturned – they cannot run the risk of leaving any arguments and submissions unused in anticipation of further proceedings. This may drag the case out, with all the consequences this has as regards costs and may have as regards judicial risk. On the other hand, arbitration may open the way for the flexible planning of proceedings in collaboration between the parties and the court, and this may offset the disadvantages of the parties having only one go. A hearing in only one instance may save time and costs compared with a two or, at worst, three instance hearing in the ordinary courts [14]. Saved time often also means saved costs in a hidden, but quite central item: the parties’ loss of revenue as a result of taking key personnel away from their regular task in order instead to prepare the dispute.

The other differences between the courts and arbitration hearings are also well known and will not be described here beyond a brief outline of the main points. The parties are able to choose their arbitrators, which may be desirable in complex construction cases; they can through arbitration obtain confidentiality (provided they agree to it, cf. section 5 of the Norwegian Arbitration Act); and they will see more active management of the case from the arbitral tribunal than from ordinary courts – in part because the procedural arrangements provide for this and in part because the arbitrators usually have a better background of experience from the industry. This may be an advantage in fact-filled cases, which construction cases often are. On the other hand, the costs of arbitration are without doubt higher than a district court hearing because the arbitrators are more

[9] This is the opposite view to that held by the renowned existentialist philosopher Linus van Pelt, who through his ghostwriter Charles Schultz, maintains that “No problem is so big and complicated that it can’t be run away from”. He does not, however, take a specific stand as regards projects.

[10] The Norwegian Enforcement Act, section 4-1(2) d). See also the Norwegian Arbitration Act, section 46.

[11] Arbitration is a possible exception here: “The arbitral tribunal shall decide on the basis of fairness only if the parties have expressly authorised it to do so” (cf. the Norwegian Arbitration Act, section 31(3)), but only then.

[12] This applies also to arbitration. See the Norwegian Arbitration Act, Chapter 6.

[13] See the Norwegian Arbitration Act, section 42; cf. section 43 concerning grounds for invalidity. Decisions contrary to public policy (ordre public) excepted, errors in the arbitral tribunal’s procedural application of law will not lead to invalidity.

[14] See the Norwegian Arbitration Act, section 21.

expensive than a court fee, and because the case is often dealt with in a broader manner (although the costs can be cut by using a sole arbitrator or written proceedings only). On a slightly different level is the difference that arbitration practice is often not made accessible to others, which means that the contributions which it might have made to legal developments are lost. However, it must be acknowledged that this situation only has special significance for parties which are either highly principled or run such large enterprises that a general legal clarification is important for them.

The possibility of choosing the arbitrators is perhaps tempting, but may also open the way for fateful choices. A good illustration here is the classical difference between the parties in typical construction cases, especially where the dispute arises from the final account: the owner demands that the contractor should establish chains of cause from the alleged cost consequences back to matters for which it is maintained the owner bears the risk, whilst the constructor invokes global considerations where an overall impression of the course of the project and the delay and cost factors are central. And whereas the owner demands that the claim be built from the bottom up, the contractor maintains that it must be justified from above, and never the twain shall meet. So should one opt for on an arbitrator keen on formalities who requires documentation or one with a freer approach who assumes that “there must probably be something to this”, and how does one know which arbitrator will be what in the case in question? [15]

It is difficult to make fateful choices, especially when one does not have an overview of the alternatives and consequences. An important aspect of leaving the settlement of a dispute to an outsider is that the parties are relieved of the burden that may be involved in having to defend a solution that they themselves have negotiated into existence [16]. But at the same time it is perilous to place one’s destiny in the hands of outsiders who per-

haps do not reveal how little they have understood of the dispute and the parties’ views and needs until they come down from on high with a binding decision – which may be a little too late. Indeed, it may well be a burden for the parties to have control, but it may be even less desirable not to have control.

## MEDIATION

We may therefore have a situation where the parties wish to have more control than third party decisions – even in the form of arbitration – give them, whilst they are at the same time unable to sort matters out alone through negotiations. In this case, mediation is an alternative: a third party assists, but does not decide.

This is not the place to go into details about the concept of mediation in general [17]. However, some characteristic features must be mentioned.

On the one hand, mediation is for most parties still something unfamiliar and therefore unsafe – there is uncertainty as to one’s own role and the role of the other participants, what means that the mediator has at his disposal, and the dynamics of the process. This is to some extent the case even when the participants have tried it before, since each mediation process is influenced by the parties and the circumstances involved. In addition, there is the uncertainty inherent in the positive aspect of mediation – that the parties themselves have control of the outcome and (to a somewhat varying degree) of the process leading to the outcome. It may be difficult to return to one’s parent organisation and say that “this is the result we have because I accepted it”.

On the other hand, what mediation in principle gives the parties is precisely unlimited control of the outcome - they can break off mediation without grounds at any time. They also have substantial control of the proceedings, within the wide framework resulting from the fact that mediation by its very nature is flexible both

[15] The belief that this can be predicted independent of the detailed circumstances of the case may well be the source of some astonishment.

[16] Cf. Vilhelm Aubert’s observation: “The form of a trial, with two parties confronting one another, each of them with the opportunity to put forward his case, and with an objective body to make decisions, gives the impression that everything which reasonably can be done to ensure a fair solution has been done.” (*Rettsosologi*, Oslo 1968, page 95, translated from Norwegian).

[17] The USA was in many respects the pioneer in developing mediation as an alternative dispute resolution mechanism, and the literature from there is abundant. However, in Norway too, we have gradually acquired presentations and discussions of legal and practical aspects of mediation in legal disputes, both in the form of “judicial mediation” which is conducted within the scope of the Norwegian Dispute Act, Chapter 8 II (see immediately below), and pure *ad hoc* mediation. See, for example, Anne Austbø and Geir Engebretsen: *Mekling i rettskonflikter: rettsmekling, mekling ved advokater og mekling i forliksrådene og konfliktrådene* (2nd ed., 2006), Per M. Ristvedt and Ola Ø. Nisja: *Alternativ tvisteløsning* (2008), Kristin Kjelland-Mørde (ed.): *Konflikt, mekling og rettsmekling* (2008) and Knut Kaasen, “‘Gaaer hen og forliger Eder, I skabhalse’, Noen avveininger ved bruk av alternative tvisteløsningsformer”, *Tidsskrift for forretningsjus (Journal of Business Law)*, 1998, pp 3-19.

as regards form and content. The criteria for resolution are also flexible; whilst the courts (for the most part) are bound by what they see as the relevant rules of law [18], there is nothing to stop mediation being based on a freer approach to the parties' interests.

In its role as a form regulated by law, judicial mediation [19] is in a class of its own [20]. The solution set forth in the Norwegian Dispute Act is that the court – after having heard the positions of the parties – may, pursuant to section 8-3, decide that judicial mediation is to take place in accordance with the provisions set forth in sections 8-4 to 8-6 of the Act, even if one of the parties to the dispute disagrees. The mediator may be a judge of the court in question or “a person from the court’s panel of judicial mediators (section 8-4(1)). The Act requires that a panel of judicial mediators be established for this purpose, often a common panel for several courts. The requirements made of the selected persons are that they “should together cover the range of expertise required for judicial mediation before the court” and that they have “the qualifications necessary to act as judicial mediators” (section 8-4(4)).

### **A “PROJECT TWIST” TO THE CLASSICAL CONFLICT RESOLUTION METHODS.**

After this summary overview of important features of litigation, arbitration and mediation, we now have a basis on which to make some observations concerning our point of departure, which was that typical construction disputes have important features in common which are of significance for how they may most expediently be resolved, regardless of whether the dispute arises during the project or not until the settling of the final account.

In this connection it is also useful to distinguish between models in which a third party decides and those in which he or she is merely of assistance.

Neither ordinary litigation nor arbitration brings anything new to the problems associated with the settling of the final account. They are methods of classical legal dispute resolution through classical proceedings based on the principle of *audi alteram partem* (both parties have the opportunity to comment on the views of the other before the case is settled). It is different if the dispute arises during the project and must be resolved there and then because the contract’s system forces the parties to do so (preclusive lawsuit time limits etc.), or because the project needs drive (management speed). In such situations, there are weaknesses associated with litigation and arbitration as resolution models. They take up time and attention in a situation where both are in short supply, and they do not provide solutions that the parties can readily embrace as the basis for their further work. Moreover, the parties must perhaps be more than normally professional in order to avoid the lawsuit’s formalisation of the dispute creating an uncooperative and less than solution-oriented atmosphere between them. Such effects are difficult to demonstrate in a measurable form, but may be far more serious than the strain of spending many hours dealing with the lawsuit.

The mediation model where a third party assists without making a decision appears as less disruptive. In general, this form is not highly resource-demanding, partly because it is flexible and subject to the parties’ control as the mediation progresses, but primarily because it does not entail “all or nothing” where everything is staked on one card at an early stage of the game. These are good characteristics, in particular in dealing with disputes during the course of the project. In this phase, full advantage may also be derived from another important property of the mediation process: as a rule, it does not create the same antagonism that a lawsuit tends to do; there is less disturbance of the focus of the project. And if the mediation is successful, what originally was a strain is turned into something positive – the parties, by working together, found a solution with which they can both live.

[18] As Aubert stresses, “the courts [cannot] deal with the dispute as a pure conflict of interests, in the same way as the parties to a purchasing agreement can. The conflict of interests must couched in a form which at the same time makes it a disagreement about rules of law or about actual facts. ... The court has only a limited opportunity to give weight to the parties’ interests.” (*Rettsossologi, Oslo 1968, pp 92-93, translated from Norwegian*).

[19] “Judicial mediation” follows provisions set forth in the Norwegian Dispute Act, sections 8-4 to 8-6, and the designation should only be used for this form of mediation. We do not have an established term for mediation of legal disputes outside the courts. “Mediation” is strictly speaking too imprecise since the word also – and traditionally perhaps most frequently in a Norwegian context (“*megling*”) – is used to denominate conflicts of interest as opposed to those of law. However, the context normally makes it clear what is meant, as in “Project Integrated Mediation”.

[20] Anne Austbø (*Tvistelovbrev nr. 8 (2007)*) points out that “the central role of mediation is emphasised by the name of the Act: ‘Act relating to mediation and procedure in civil disputes’. The Civil Procedure Reform Committee saw the question of whether it is possible through rules in the Dispute Act to pave the way for creating a climate and culture for amicable settlements as crucial.” (*Translated from Norwegian*).

These positive effects can be reinforced if mediation is not just used ad hoc, but is made a part of the project, in recognition of the fact that disputes, and hence a need for mediation, normally are not one-off phenomena in projects, unlike in the case of, for instance, a pure purchase agreement.

This model of mediation seems to be gaining ground internationally. In its Norwegian variant it has been in use for some years – although not everyone in the construction industry seems to be acquainted with it. Phenomena should have a name, and in this instance a fitting name may be Project Integrated Mediation (PRIME).

## WHAT IS PROJECT INTEGRATED MEDIATION (PRIME)?

### A brief presentation

In essence, PRIME consists of three elements: (a) one or more mediators (b) are drawn into the project from day one (c) to maintain continuous contact between the parties, regardless, in principle, of whether there are any conflicts at the time. These simple and straightforward elements provide the basis for a broad spectrum of methods for conflict resolution because a forum is formed which paves the way for a flexible approach to the dispute.

Project Integrated Mediation does not normally mean that conflicts are prevented – it is all about handling conflict [21]. Furthermore, PRIME means that outsiders are drawn in. The model therefore differs from resolution models based on the involvement of levels over the project organisations on both sides, for example in the form of a “bosses’ forum” or a “contract forum” composed of personnel other than those who are running the project (see section 2 above).

Lastly, PRIME is in place from the outset. This means that the mediator becomes acquainted with the contract, the project, the challenges and the personnel before the going gets tough, and the parties get to know the mediator. Two advantages are thus obtained: the threshold for bringing disputes (or signs of disputes) before PRIME is lower than the threshold for issuing a writ, and the mediator already has sufficient understanding of the situation to be able to provide effective help swiftly. In this way, the frictions of project life are dealt with at the lowest possible level of conflict. Success here will mean that a great deal has been achieved.

In what follows we shall look in more detail at how the PRIME form can be developed, some foreign variants and some experience of PRIME in Norway, before we conclude with a few evaluations: does PRIME have anything to offer?

## VARIABLES IN THE SHAPING OF PRIME

The PRIME form per se lays down virtually no binding guidelines for the basic choices the parties must make when establishing the scheme. Certainly, there are some who hold “orthodox” views and believe that certain patterns must be adhered to, but I am not one of them. As in other mediation, the basic view that “purpose governs form” prevails. The purpose is to help the parties build a sufficiently secure basis on which to make choices they can defend – whether it be to settle (which is of course the most agreeable) or not to settle (which in some situations may nevertheless be the best solution). Within the bounds of reason, there are seldom grounds for imposing special constraints on the choice of form in order to reach this goal.

A fundamental question is whether the mediator should be nothing more than a go-between or whether he or she should also – possibly under certain conditions – be able to make decisions which are binding on the parties. This question is one of practical importance, but not for the reasons one would expect (and which result in a great deal of effort often being put into defining conditions for and effects of binding opinions from different types of “dispute resolution boards”). In my view, the point is that binding opinions must be based on neutral proceedings in which both parties are heard, which in many ways resemble the process leading up to an arbitral decision (or for that matter, a district court ruling). This lays down constraints which are not so readily compatible with effective mediation. For example, it is difficult to hold separate meetings with the parties if the aim is to provide a binding opinion, rather than help the parties agree upon a solution. One must therefore choose at a relative early stage in the handling of a dispute whether to aim at one or other form of contribution from a third party. If the choice entails refraining from using the means that effective mediation calls for, the advantages of this flexible system will be replaced by the disadvantages of a “mini arbitration”, which we have looked at in brief in section 3 above.

Experience seems moreover to suggest that the question is more one of principle than practice. Even where

[21] But here it is tempting to speculate: A standing, effective mediation scheme will probably give rise to various types of impulses capable of neutralising conflicts which under otherwise identical conditions would have come into full bloom.

PRIME is required to be able to result in binding decisions, it is unlikely that this is what will happen. Instead, the mediator's advice and guiding viewpoints on the basis of procedures in which both parties are heard are perceived as such powerful signals that the question of formal binding is not pushed to its logical extreme.

A more important practical question is therefore how many mediators should there be – one or three [22]. The cost aspect is of course of some significance here, but more importantly three mediators will be able to add greater dynamics and breadth to the mediation than one would. But the most important aspect is perhaps that it may be difficult to find one person who covers all types of knowledge for which there may be a need in such a long-term situation. Legal practitioners have, as we know, good all-round versatility, but engineering or project administrative skills would obviously strengthen the team. This is not least a question of the mediator's legitimacy in the project.

With three mediators, such considerations may be accommodated. However, if the decision is made to have one, priorities must be established. The distinctive character of the project may suggest otherwise, and of course the individual qualifications of experts vary a great deal, but I think, as a general rule, that it is nevertheless easier to teach a legal practitioner what he needs to know about technology, finances and project management in order to help with dispute resolution than to teach an engineer, economist or project administrator what he needs to know about the law in order to do so – to the extent that it is felt the process should have such a foundation. But the best solution will often be to say yes to “having one's cake and eating it”.

The approach to the work involved in PRIME is thus governed by the purpose. Procedure and means are clarified underway as mediators and parties work together, and the whole arsenal of mediation weapons is available. The method used in the preliminary handling of a dispute is seldom the same as that used in the concluding phase leading up to the moment of truth – and may range from “a good conversation” to a “hammer-and-tongs” discussion via signals of the strength of

positions and arguments. But some fixed points must be established. Firstly, the conditions for and effects of formal opinions or decisions from the mediators about questions that might have to be brought before them for decision should be considered thoroughly and set out in writing. Secondly, the ground rules for the mediation process should be clear and agreed upon. These include impartiality, ensuring both parties are heard, openness about the process at every stage (but of course not always about substance), and the freedom of the parties at any time to oppose further mediation – including a recommended outcome.

The intensity of meetings between mediators and parties will of course vary depending on the type and phase of the project and the level of conflict. But PRIME presupposes that there is no waiting until the conflicts are defined as such – before that stage is reached, insight, trust and forms of communications should be built up. Moreover, one of the points of PRIME is that the parties do not need to initiate dispute handling by defining an outstanding issue as a dispute. They can “air” the matter earlier and through their relatively regular contact with the project, the mediators will also acquire a foundation for intervening in matters at an early and preferably quite informal stage.

## INTERNATIONAL INSPIRATION

PRIME is not a purely Norwegian invention. Although an early variant was introduced in some of the petroleum contracts in 2000 [23], previous traces of the idea can be found internationally, for example, in the FIDIC contracts. However, developments first truly gathered pace when private organisations marketed dispute resolution boards as an option in (particularly) international contracts and at the same time established a milieu for developing clauses, methods and exchange of experience. A couple of examples may be mentioned briefly by way of illustration.

Both the International Chamber of Commerce (ICC) and the Dispute Resolution Board Foundation (DRBF) have developed rules for dispute boards [24]. The main features of these rules are similar. The parties to a contract appoint a dispute board, usually consisting of

[22] More than three is of course in principle also possible, but will be costly and inefficient. Two may be a better alternative, but problems may then arise if binding opinions are to be issued. See immediately below.

[23] See the Norwegian Total Contract (Norsk Totalkontrakt - NTK) 2007 Article 37 with regard to the “arbiter” (who, unlike the umpire in the Norwegian Standards, follows the PRIME pattern, and therefore should have a different title in order to avoid confusion). The scheme has been used in a couple of major offshore projects.

[24] See respectively [http://www.iccwbo.org/uploadedFiles/Court/Arbitration/other/db\\_rules\\_2004.pdf](http://www.iccwbo.org/uploadedFiles/Court/Arbitration/other/db_rules_2004.pdf) (ICC's rules from 2004) and [http://www.drbf.org/manual\\_access.htm](http://www.drbf.org/manual_access.htm) (DRBF's manual from 2007).

three independent persons. The board is not an arbitral tribunal, and its advice or decisions cannot be legally enforced, but its powers may range from providing informal assistance to making decisions.

The parties choose the role they would like the board to have by agreeing on one of the three alternatives defined by the rules (here using the terminology of the ICC rules) [25]. The first alternative is a Dispute Review Board which issues recommendations to the parties. The second option is that the board is established as a Dispute Adjudication Board which issues decisions in disputes brought before it, whilst the third alternative is a Combined Dispute Board which does not go beyond making recommendations unless one party requests a decision and the other party does not oppose this.

The ICC rules acknowledge the need for more flexible forms of assistance from a dispute board than would normally fall under one of these three alternatives. When the parties are in agreement, the Dispute Board (DB) can assist the parties in an informal manner by “conversation among the DB and the Parties; separate meetings between the DB and any Party with the prior agreement of the Parties; informal views given by the DB to the parties; a written note from the DB to the Parties; or any other form of assistance which may help the Parties resolve the disagreement”. In this form, the ground rules are set for the dispute handling method which in practice characterises PRIME in Norway, where neither formal statements nor decisions are usual.

It may be natural to apply the rules pertaining to dispute boards in international contractual relationships, and they can also without doubt serve as inspiration. However, for purely Norwegian conditions they are perhaps not so necessary. Moreover, the division between the alternative forms may be rather rigid.

### **WHAT SPEAKS FOR AND AGAINST PRIME?**

As has, I hope, been demonstrated above, PRIME has some distinct advantages. The approach entails a low threshold for a flexible and swift handling of potential and ongoing disputes in projects. PRIME can therefore be an effective tool in efforts to smooth the way for concentrating on the essence of the project.

However, objections are conceivable.

One objection may be that the parties, by bringing in a third party, expose their positions, arguments and priorities in a way that binds them and may therefore inhibit agreement. However, this will of course also be the case when the parties negotiate directly, without assistance from a third party. It is precisely this immediate link between taking a position and exposing oneself that often prevents the parties from reaching a solution through direct negotiations. A third party can break the link – a party does not need to expose itself directly to the opposing party, just to the mediator. One of the principally most important features of mediation is that the mediator is a filter between the party’s concession and the consequence thereof.

More prosaically, it could be objected that PRIME implies the parties using unnecessary resources on dispute handling before there is any dispute. However, the resources (costs involved in having mediators and one’s own invested time) are only a waste or disproportionate if it is assumed that there will be no dispute in the course of the project, or in any case that the benefit of handling the dispute using PRIME is not commensurate with the investments in the model. Neither of these assumptions seems particularly convincing. It is beyond question that one court or arbitration case saved by far outweighs the possible costs of the PRIME alternative. In a sense there is a certain parallel in the catch phrase “If you think knowledge is dear, try ignorance!”

A more fundamental objection might be that PRIME leads to unfavourable solutions, either in that the parties are duped into accepting results they do not want, but fail to resist, or in that the solutions are divorced from the dictates of the contract and the law. Here we come back to the intricate issues previously mentioned (sections 3 and 4) which concern the parties’ control of the dispute and the relevant considerations involved in their decision. Certainly, cases are imaginable where there is an imbalance in the relative strengths of the parties (in general or in specific situations, based on, for example, liquidity requirements or the qualifications of key personnel) that may result in their failing to represent their own interests in a dispute. However, the sort of exposure that this will subject a party to during mediation will also be felt in negotiations without the assistance of a third party – and perhaps at least to the same extent. Admittedly, a mediation scheme may, in given situations, result in a pressure to which the party would not have been exposed in direct negotiations, but the

[25] See the following ICC Dispute Board Rules (as at 1 September 2004), in particular Articles 4, 5 and 6, respectively.

scheme may also help the party consider positions and alternatives more appropriately than it could do alone. Thus, what must be central is the party's own choice. As long as PRIME can never force a party to something it does not want, it cannot be a weighty argument against the scheme that in a given situation it will lead to the party being exposed to pressure and may provide the basis for solutions other than those that would presumably have followed from rules of law alone.

Here, there is a practical consideration: Disputes in large projects may of course relate exclusively to the law, but just as often they involve a substantial factual content. The idea that the contract and contract law give precise answers may in some cases be quite exaggerated. This means that a considerable risk is involved in pushing issues to their extreme, especially where the settlement thereof tends towards either/or more than a sliding scale of discretion. A risk-reducing approach to the dispute will therefore often in fact involve gradually identifying relevant factual and legal aspects whilst continually evaluating the consequences they will have, and on this basis make broader assessments of acceptable outcomes – that is to say, “assisted negotiation” where the mediator is responsible for the assistance [26].

On a slightly different level is the objection that PRIME may provoke disputes that would otherwise not have become a problem. The parties are forced into establishing and justifying potential differences before they and the differences are ready for it. In response to this, there is little one can say other than that if PRIME works in this way, both the mediators and the parties have failed in their fundamental task – to cooperate on a process. Naturally this may happen, but obviously not as an inevitable consequence of entering into mediation. Quite the reverse: the very object of PRIME is to find the simplest and most efficient method of handling potential disputes – and then to use this method until a joint decision is made that it should be changed. If this can be achieved, potential disputes will not become greater than they should and must be.

It is perhaps more likely that the threshold for bringing an issue before the mediator becomes too low – the parties are not subjected to sufficient pressure to reach a solution at a lowest and earliest level. It may be very helpful to have to identify and objectify the issues with a view to presenting them to a third party, but at the same time there

is a danger that the higher up in the hierarchy one comes, the greater the ignorance of the facts from which the issue has arisen. Again, the answer has to be that parties and mediator must cooperate on appropriate forms – including referring the issues to continued negotiation.

The last objection to PRIME which will be mentioned here relates to the more indefinable effects of the method: the common “project spirit” is undermined when the parties are unable to solve their problems themselves. And this is an effect that also simply cannot be dismissed. However, all experience suggests that when the parties do not manage alone, it is better that they collaborate on a solution together with one or more mediators than that they enter a straight confrontation with a subsequent court decision. The dispute that took focus away from the project and was a strain on the spirit of cooperation and everything good is turned into something positive, building on the relationship between the parties at the instant they – each with their “hand on the wheel” – succeed in finding a solution they both can live with. The strain becomes a strengthening.

This requires realism – which may be challenging to cultivate without substantive confrontation: Does this viewpoint hold? Is my factual understanding adequate? What are the consequences of being wrong, etc? A major contribution of PRIME is that the process forces the parties to adjust their views in the course of the project. – it is not easy to maintain an untenable view through to the settling of the final account.

### **AN ILLUSTRATION: THE NORWEGIAN PUBLIC ROADS ADMINISTRATION'S BJØRVIKA PROJECT.**

To the best of my knowledge, the Norwegian Public Roads Administration was the first public owner to put to use the mechanism that in this article I call Project Integrated Mediation. This happened in the Bjørvika project in the centre of Oslo, a project joining two tunnels and a main road (the Festning Tunnel, the Ekeberg Tunnel and Mosseveien (E18)), and involving three main contracts totalling some NOK 3.5 billion [27]. In each of the three contracts a “dispute board” – later named the Conflict Resolution Board (CRB) – consisting of the same three persons appointed jointly by the contracting parties, was established [28]. From immediately after the signing of the individual contracts, the CRB acted as a supplement to the other conflict resolu-

[26] See a description in Kaasen, “Gaaer hen og forliger Eder, I skabhalse” (see Note 11 above), page 14 seq.

[27] See <http://www.vegvesen.no/Vegprosjekter/Bjorvika> for an overview of the project.

[28] The following description is based on my experience as leader of the Conflict Resolution Board.

tion methods in the contracts (which are based on NS (Norwegian Standard) 3430).

According to the contracts, the purpose of the scheme is to “assist the parties in issues where disagreement arises concerning contractual matters (not technical), by a) giving informal advice when both parties agree to it, and b) implementing a formal process of conflict resolution at the request of at least one of the parties”. As a general rule, the conclusion of the conflict board should “have the character of non-mandatory advice” which only becomes binding on the parties if they do not object within a specified time limit. Objection may lead to fresh negotiations between the parties or a court or arbitral tribunal hearing in accordance with the ordinary rules of the contract.

Disputes may be brought before the dispute board within 30 days after notice is given of the other contracting party’s rejection or “unsatisfactory standpoint”, otherwise “the claim is lost”, whilst the dispute board should give notice of its view within 90 days after the parties have put forward their written presentations of the case. The contracts say little however about the working methods of the Conflict Resolution Board, beyond stating that the parties have the right to be heard and the right to hear. But the parties “should agree on a set of rules for the appointment, mandate, procedures and working method of the dispute board”. Unless otherwise agreed, this set of rules should “follow internationally published rules for dispute boards or dispute review boards with reference rules published by the ICC on 1 September 2004”, that is to say, the rules mentioned in section 6.3 above.

No further agreements as to the dispute handling method of the CRB have been made. However, each of the three members of the CRB has entered into an agreement with the parties in each of the construction contracts. In these agreements, it is stipulated that the CRB is to operate in accordance with the said frameworks set forth in the contracts and otherwise as agreed by the parties – implying ad hoc [29]. These ad hoc arrangements have in practice developed into a pattern for the CRB’s work.

The most important elements in this pattern are identification, facilitation and processing of (potential) disputes.

Identification involves establishing mechanisms for catching the disputes in time. As mentioned, general

project experience indicates that problems do not disappear simply by being ignored, they multiply. The mechanisms for bringing them to the light in the CRB are quite banal: the threshold for identifying them must be made as low as possible by establishing trust so that openness is not seen as unprofessional or a loss of face, and furthermore there must be practical ways of doing this.

Trust can only be built up over time: it is perhaps here that Project Integrated Mediation shows its greatest strength compared with ad hoc mediation. On the practical side, the “concerns list” tool has proven to be effective. Before each meeting with the CRB, the parties – preferably jointly, but if necessary separately – submit a list of aspects of the project which “concern” them at the time, with brief documentation attached where appropriate. The concern need not mean that there is an established conflict, still less that it is not possible to resolve the situation through ordinary negotiations. What is decisive for whether a matter belongs on the list is whether the party or parties think that they see a matter which might prove difficult. This may be quite fundamental matters such as difficulties in establishing a revised progress plan after many different types of interruptions in progress, or limited issues as, for instance, the criteria for pricing a defined variation job.

Facilitation consists of the parties and the CBR jointly finding a suitable way of dealing with the concerns list. Some points on the list are simply noted at the present stage, but followed up on later lists. Other points may be taken up more or less spontaneously: the parties give an account of their view and what they base it on and the CRB acts as “agents of reality”, without expressing a view, whereafter the parties find a solution. And still other points on the list clearly need better preparation before anything meaningful can be done with them in a CRB context. The parties must discuss among themselves to clarify exactly what the disagreement consists of, they must find documentation and present arguments, or external factors such as requirements set by the authorities must be clarified. Facilitation may take place from one CRB meeting to the next, or it may stretch over a longer period of time. But the object is the same: the parties and the CRB must acquire a clearest possible picture of what the issue relates to in order then on this basis to cooperate on how it best may be dealt with.

[29] Moreover, it is stipulated that the CRB member cannot be relied on as a witness in later disputes concerning matters dealt with by the CRB, and that concessions made in the CRB cannot be relied on in later disputes.

In this phase, too, trust is a decisive factor. Without trust it is difficult for the parties to cooperate on the facilitation of an efficient handling of questions on which they profoundly disagree. Experience from Bjørvika is that the – admittedly few and simple – formal guidelines which were set forth in the contracts did not play any particular role in this process. The most important is the practical approach to a specific problem, and it requires a trust-based collaboration between professionals who wear the shoe - and therefore know where it pinches.

Processing designates the final brick in the CRB process. It results either in the problem being solved – by the parties themselves or with the aid of the CRB, or in the parties having to find the solution outside the CRB – that is to say, in accordance with the contract's general system for dispute resolution. Again, it is up to the parties, in consultation with the CRB, to set the course. In theory, there is a wide range of possible methods that can be used – from the CRB gently massaging the parties to it issuing binding opinions. At the time of writing, the CRB has not been asked to provide a binding opinion in this project. Instead mediation processes have been successfully used. These have varied in their detail, but all have consisted of a dynamic approach to the issues in a continuous collaboration between the parties and the CRB and a development of the mechanisms from the opening to the closing phase.

There may be several reasons why binding opinions have at the time of writing not been used. The main reason is perhaps that the CRB would not feel comfortable issuing such opinions without being able to build on a broad preparatory process which would bring it closer to an arbitration process than has been seen as useful. In practice, however, the explanation is perhaps rather that the parties and the CRB have, during the process, agreed that the CRB as time goes by (often in separate meetings) should indicate its view on, for instance the process risk and the strength of the parties' submissions and arguments. On this basis, the parties have managed to find solutions they were able to live with, partly after lengthy rounds of mediation in which the parties probably at times quite rightly understood individual messages from the CRB as quite plain [30]. As in other mediation: purpose governs form, and the parties draw on the trust account when things get tough – which they inevitably will do.

Without looking in more detail at specific instances of board mediation or the different possible elements in the mediation process [31], it can be established that the process is primarily based on meetings of different character. It is through this process that identification, facilitation and processing take place. Some of the meetings are ad hoc in order to make progress with an identified problem, and some are regular to keep the CRB up to date on the project – and to allow unpleasant questions to be asked, which may bring to light matters that should be dealt with. The meeting participants are the CRB and the parties' project and construction managers and their planning and contract personnel and consultants, depending on the particular case and the requirements arising from it.

The CRB keeps minutes of the meetings. In addition to the ordinary minutes, the CRB's considerations regarding the issues discussed in the meetings have often been noted – in a distinct print. The considerations have at times been presented in the meetings, but may also be the result of the CRB's subsequent deliberations. These may consist of emphasis of what the parties have said (“the CRB notes that ...”), summarising advice (“the CRB finds that the essence of the discussion is ...”) or suggestions (“the CRB gave no views on the solution to this issue, but reminded the parties that ...” or “the CRB suggested that one possible way forward might be ...”). Experience has shown that the CRB can thus put across its view in an efficient and relatively informal manner, and that the parties perceive this as helpful, without this mixed form seeming to cause problems. It has also been customary in the minutes to give the parties “homework” to do before the next meeting.

The CRB is not a replacement for the contract's general systems, nor does it replace the contract's requirements for notification of different claims in certain forms within certain deadlines, typically the rules of notification of the variation mechanism. It follows from this that no modifications have been made, for example, to the general notification rules on account of the CRB institution. Another matter is that the parties in a mediation situation have of course the opportunity to use relevant conduct with respect to the notification rules as a factor in the mediation. For example, the assessment of process risk might be completely different if the claim possibly can be precluded under the contract, and a claim which probably is precluded can nevertheless be brought into mediation to help break a deadlock.

[30] It seems justified to say that the parties thus far have a positive experience of the CRB scheme in the project, which as at May 2011 has reached about 95 % completion without there being any unsettled disputes between the parties.

[31] Some practical considerations can be seen in Kaasen “Gaer hen og Forliger Eder. I skabhalse” (See Note 11 above).

## DOES PRIME WORK?

We are gradually beginning to have some years' experience with Project Integrated Mediation. Contracting – particularly in the public roads sector – seems to date to have used the scheme the most, but examples are also found in data deliveries and offshore fabrication – with the latter sector being the first to systematically use the system [32]. Although it is difficult to have a clear overview, the trend seems to be that more contracting parties are now using PRIME.

For obvious reasons, nobody can have a certain opinion as to how successful PRIME is in general. Jungle telegraphs are rarely clear and unequivocal. But in this instance they can hardly be said to give particularly negative signals; quite the reverse. Most recorded feedback from parties and mediators is positive. PRIME is perceived as flexible and swift assistance with a low threshold, which is therefore worth considering in recognition of the fact that disagreements occurs in major projects and that it is costly to allow disagreement to drift unresolved.

This feedback is not surprising. A characteristic of PRIME is that the arrangement is a structured arena for flexible handling of large or small pebbles in the shoe of a project. Those wearing the shoe have the lead in choosing how the pebbles are to be removed, but they receive skilled assistance from persons who know the project and its challenges without being parties, and who have an insight into the tools available for removing pebbles. The point is this that the contract establishes the arena, the rest is sorted out underway. The framework is fixed, the content flexible.

If one is successful in establishing good collaboration for problem resolution without allowing the fact that one has problems to be a distraction, then much will have been achieved. PRIME is a suitable means for reaching this goal.

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[32] See Kolrud, *Ny standardkontrakt for offshoreleveranser; NTK 2000 - Norwegian Total Contract 2000*. *Tidsskrift for forretningsjus (Journal of Business Law)*, 2000, pp 57-66, on page 66 re “a wise man on site”. For further details, see Kaasen, *Petroleumskontrakter (Universitetsforlaget 2006)* pp 877-881.

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## 12. TOWARDS FUTURE TUNNELLING PROSPECTS AND CHALLENGES OF DEVELOPMENT ORIENTED TUNNEL CONTRACTS

BEITNES, Anders

### INTRODUCTION

New generations of tunnels will meet new challenges within such aspects as environmental impact, enclosed sites and neighbour concern. Traffic tunnels in particular are subject to enhanced requirements with respect to safety and serviceability. Cost of operation and maintenance has for some owners become a night-mare. At the same time, there is an inspiring development in materials and methods driven by other industrial sectors, such as telematics, oil recovery, building and kinematics. One thing is for sure, the challenges of tomorrow do call for other solutions than those of yesterday.

Our endeavour should be to make the development happen in an optimized degree and pace. Clients need to tone down or leave some of their codes of practice and to challenge the consultants and research institutes for improved technology. But lowest possible price in every aspect and fear of risk are two enemies of technical development. The same goes for a bureaucracy where the employees find their comfort primarily in sticking to codebooks. Focus on functional requirements and LCC would be an improvement, however with limitations.

Could a new practice in contracting also boost the development? This paper is aiming to bring forward a discussion of whether and how different requirement specifications and different tender and contract management practice can bring more prosperous business for the contractors as well as serving the market with more safe and cost efficient tunnelling, enhanced functionality, improved safety and lower maintenance cost.

### WHERE COULD WE IMPROVE AND WHAT COULD BE GAINED BY WHAT KIND OF DEVELOPMENT?

- More safe and cost efficient tunnelling
  - Completion of rock support and safety installations at the tunnel face may provide a safer and more comfortable working ambience. Working conditions at the tunnel face are better because of the fresh air support, good working light and less traffic hazard.

- Worksite close to the tunnel advance face may also provide conditions for improved quality/ less mistakes and faults in the permanent structures and installations, as this is the section where we have better survey, more versatile production units and also the best experienced and productive crew.
- For a typical highway or rail tunnel, the excavation & rock support do represent less than ½ of the total value of the product. If a major part of the “furnishing” could be produced by the same plant and crew within the sequence of tunnelling, its productivity would boost and at the same time give room for a relief on the stress for quickest possible advance.
- Sprayed membrane for water insulation integrated with shotcrete lining is an example of solution which is perfect for early completion.
- A relief in advance pace is furthermore an important factor for achieving high quality in time-consuming operations such as leakage control.
- Introduction of non-petrol-fuelled machinery and transport systems is important both for internal HES and external and global environment.
- Less environmental impact
  - As indicated above, high quality in leakage control normally does require significant time. And requirements do typically become more and more strict (to the safe side). This is due to more restrictive legislation and a higher awareness among governmental and political representatives after exposed “scandals” where certain localities experience negative impacts in biotopes and vulnerable groundwater systems. The response from tunnellers must be more consistent and thorough technology, competence and perfection in all leakage control work. Most effective is enhanced ability to choose and perform correct drilling pattern, materials and procedures for pre-grouting in actual rock mass conditions. This will gain both the result and the economy.
  - Fumes and exhaust from blasting and diesel engines may harm the local environment and CO2 emissions should be reduced also by the tunnelling

- industry. Use of emulsion explosives and electrically propelled units (like transport belt) are among the adequate measures in this aspect.
- Emissions of pollutions and suspended mud from a tunnel site to a sweet water recipient (or municipal pipe systems) do from time to time cause severe concern and very costly clean-up situations. It may clearly be put higher emphasis on the purification systems on released drainage as well as cleaning of the road conditions inside a tunnel drive and the out-door yard.
  - The visual impact of tunnel entrances is often quite brutal. This is not necessary if one could minimise rock cuts by exploiting the possibility to “sneak” tunnels in under a site specific collar of cast-in-place concrete, soil backfill and re-vegetation at an early stage.
- Enhanced or combined functionality
    - To-days code of practice is a collection of single solutions and improvements for single functions or problems. Creative focus on the whole range of functional requirements or expected performance of a tunnel throughout its prospected service time may lead to more cost effective solutions. Some examples:
      - Pre-manufactured wall linings may be developed further to contain fixing for light, ducts for cables and safety installations. Also, they may act as a permanent formwork and easily maintained coating for compact cast-in-place rock support with draining and frost insulation ability!
      - Ducts for washing and drainage are normally placed beneath the gutter and require frequent deep sandtraps which need to be emptied in the maintenance campaigns. Such deep pits often constitute a problem in rock tunnels, as they require extra blasting which may damage the pre-grouted zone of the invert. And the problem may be larger in tunnels in poor rock conditions, where it creates weak points in a water-tight concrete invert. A potentially fruitful concept would be to introduce a centrally oriented precast duct of such size, shape and alignment that it acts as a longitudinal, self-cleaning sandtrap. Run-out could be in a thoroughly designed stilling basin at the lower end of the tunnel (or adjacent to the pump basin).
  - improved safety
    - In single tube tunnels, which still will be a viable concept for county roads, the hazard rate causes concern (even if it is less than on open roads), and then very much connected to potential meeting accidents. A concept for lane division could be of interest, provided it may be retracted or folded for occasional crossing in emergency situations.
  - lower maintenance cost
    - Some of the above suggested technical elements will contribute substantially to reduction of maintenance cost, e.g. super-smooth wall surface, self-cleaning flush water systems, improved protection of cable ducts.
    - For road base maintenance, it has been experienced both frost heave and reduced bearing capacity due to high contents of fines in the sub-base. The clue will be a good, consistent drainage layer and strong enough or stabilised material in the sub-base. A consistent drainage layer may come from coarse fractions of local tunnel spoil, stabilised by use of cement. That will constitute an excellent road base for the excavation phase, provided there is a solid road surface or a provisional dirt surface which is separated by use of geotextile.

## WHAT ARE THE HINDERING ASPECTS AND MECHANISMS?

Given that these and many more examples point out prospects for “better” tunnels and tunnelling, it will be of common interest to the public and to the industry to find out what is holding this development back. Probably no single person understands this to its full depth. I am quite sure that a lot of the explanation is connected to comfort in old practice (conservatism) and a lack of procurement, contract and specification codes that may allow for new ideas. A little closer look to some of the elements is indicated below:

- Lowest possible price
  - In every aspect of procurement and purchase for design and construction there is an endeavour to seek low expense for every service and item, as this may seem to give improved budget control.
  - Even with a view on long term costs and proper investment analyses, the financial aspect tend to give poor solutions because of too high internal interest in the models for calculations. (“Do not care about what happens in 20 years, the present value of costs at that time is close to zero.”)
  - Services and items that bring smarter solutions as well as improved quality and long-life performance naturally will have a higher up front expense.
- Fear of risk both by bureaucracy designers, checkers and contractors
  - It takes courage to stand for new ideas and unproven technology.
  - Proper risk evaluation has not become an every day’s tool in all positions where decisions are taken. Particularly missing is the art of seeking upsides and possibilities as an addition to the assessment of hazards and their probability.

- In all organisations, there are people who tend to be or become risk averse in their attitude. And you'll find them more often in those positions where one has the duty to control or approve, more than in the "invention department".
  - In the business of design and consultancy, it is impossible to utilise only the progressive, creative and brilliant people. Young people with a lack of experience and/or proper guidance understandably find it more convenient to use copy-paste more than individual and original design. My observation is, regrettably that also well experienced advisors tend to stick to that solution, much because of the cost and resource aspect, but also because of fear of risk.
  - Traditional builders (tunnel builders are no exception) are far too afraid of technical and financial risk. Securing a small overhead in a chain of well-known processes and distributed risk is more often the principle than going for a huge surplus with a certain probability of downside.
- Tender practice
    - Traditional procurement regulations (and this is strengthened by revised national standards strictly adhering to EU rules) make alternative solutions problematic or even reason for disqualification when a completed design is the basis.
    - EPC [33] contracts are the natural answer to this, as they have a clearer base for utilising functional requirements as the specification level in the BoQ [34] and therefor allow or even favour new and smarter solutions. There are at least four problems that prevent such contract practice from becoming a success regarding technical development:
      1. Functional requirements may have only indicative or relative quality parameters, unlike process specifications where strength and dimension can be controlled exactly. Not without reason, there is a fear of championship in cheating the system.
      2. Contractors who are put to manage the designer tend to look upon that as merely an expense in his budget, forgetting the upside of thorough and smart design.
      3. Professional clients, such as the national road departments, have their thoroughly elaborated and many times revised codebooks for almost all actual items, processes and solutions. Deliveries in accordance with those are widely accepted as a guarantee for high quality. Therefor the road department does not want to omit those codes even in a EPC or BOT contract.
4. Even if the client opens for relief in that aspect, the contractor may seek comfort or safety (less risk) in following those codes strictly. Particularly in PPP [35] contracts that include the responsibility for maintenance costs in a long perspective, there is according my observation, mechanisms that rather lead to conservatism than innovation. I suspect the financial and legal decision makers in the private entities do require adherence to national standards and codes of practice, such that they may have a safer position if there is a break-down or enhanced maintenance need.
- Stressed planning and execution program
    - Most infrastructure projects in Norway are at the time of political and financial "go-ahead", substantially overdue regarding public demand as well as being bound to central yearly budgets.
    - The constraint of time does require the project organisers to start execution without any further delay. In this picture, there is little room for new ideas, ingenuity and procurement processes that include a lengthy technical development.
  - Lack of precise and clear functional requirements
    - As indicated above, lack of precise specifications with nominal quality parameters makes one fear a competition in cheating and poor solutions.
    - There has been both research and gathering of experience in a considerable extent throughout the last years regarding usefulness and applicability of functional requirements. For road tunnels, this has been driven by the fact that a lot of road sections in Norway have been under privatised maintenance contracts. The experience does compel the administrative units to challenge and improve the specifications. Due to the insufficiency of requirements, there has then been a move towards more activity based contracts instead of the original concept of maintained standards.
  - Too small incentives and risk capital in the supplier industry.
    - As long as the suppliers meet mostly scepticism and defensive attitudes among clients and main contractors, they are not tempted to invest in and promote new ideas.

[33] EPC = Engineering, procurement and construction

[34] BoQ = Bill of quantities

[35] PPP = Public Private Partnership

- As long as proven and centrally approved solutions sell in a steady pace, it is not required from a commercial point of view to engage in development of competitors to a blooming product line.
- Developing new solutions for such items as e.g. fire proof water and frost insulation probably will require long and expensive product development and approval processes. Lack of risk willing capital in the industry and low probability for quick return on such investments understandably are hampering factors.
- Patents may become set-backs as that may limit the implementation in tenders for open competition.

### HOW TO INTRODUCE OR BOOST DEVELOPMENT?

The first condition is in my opinion a bold, competent and decisive client. He must have a clear vision of what performances should be improved as well as a well-tuned picture of values. Then he should seek advice in a manner that exploits creativity, ingenuity and common sense to change the vision into realistic goals and guidelines for a desired development. Value engineering may be one viable and efficient technique in that endeavour.

Second condition is the technology itself. Both pure, sudden ideas from individuals and a logical co-operative process with an element of inspired, creative ingenuity may act as first step for new solutions. This can happen in all kinds of organisations: clients, R&D entities, consultants, contractors and suppliers. In practice, there is no shortage of ideas out there. The limitation is proper engagement and instruments for building a value chain, optimisation, refining, production method and approval, often called the innovation phase. It takes time and patience, may run into disappointments, conflicts of interest and shortage of funding. Realistic prospect and efficient project management are clues.

The key lies within the client. Leading clients have to want and to inspire such innovation. Most important is perhaps to convince the industry of predictable strategies for implementation. The strategy for implementation may take several courses, all requiring a dedicated and consistent principle for procurement and contract.

- One rather safe and predictable strategy with low risk is to introduce a plain development contract where the delivery is a documented prototype or a completed installation i.e. in a section of a tunnel under construc-

tion for the client. Norway has a system called OFU [36] which may be entered into without competition, but with a rather limited value. Patents are not compromised and the outcome has rather limited obligations.

- Probably, a fair competition may be introduced for more comprehensive development projects on the basis of a set of general goals and by using the procurement method of competitive dialogue. In that case, tenderers compete with ideas and development resources as well as cost for the process and industrialised implementation. Original IPR [37] and/or patents may be preserved or bought by the client and the production privileges may be protected, but the outcome must be a technology and a documentation which afterwards is available for all contractors.
- Use of competitive dialogue may in it self open for development in a broad spectre, as there shall be phase where the solutions are elaborated on base of suggestions. This happens prior to contract throughout a (typically ½ year) dialogue with the client. One major advantage is that this gives time and reason to build a comprehensive value chain and to exploit the problem solving competence and ingenuity by suppliers and consultants and to utilise this for competitive strength. This procurement principle has been used for a challenging cut & cover tunnel in Trondheim and it led to several innovative techniques and solutions as a side effect to safe performance.
- Comprehensive tenders for e.g. a specific tunnel may include an ambition to implement a specific new product, design or method as a condition. In such case the innovation phase should have been finished or passed the stage of verification. The road authority did for example introduce the industrial use of emulsion type explosive as a condition in a large tunnel project for the Oslofjord crossing (opened in year 2000). This had a major impact and has later improved the working conditions for all the tunnel industry.
- In an ordinary contract, there may be several openings for development projects parallel to the construction. One example is utilisation of fly ash to obtain low heat concrete in the cut and cover tunnel in Trondheim. The first concrete sections were produced with a range of recipes and full and extended documentation of both young concrete and long time performance was performed in co-operation with SINTEF [38] and the

[36] OFU = publicly funded development contract

[37] IPR = Intellectual Property Rights

[38] Sintef is a research organisation covering multiple sectors including the COIN Group

R&D department of the road authority. The result will be favourably implemented within the project, bring enhanced competence for those involved and become a basis for new codes of practice.

Outcome of development contracts may become flops, e.g. because of unforeseen showstoppers or parallel inventions of superior value. Even so, the attempts, if properly documented will act as valuable additions to knowledge and experience.

### WHERE TO IMPLEMENT?

The record of innovation in public road tunnels is not impressive as things are today. The central road authority is responsible for the TERN [39] road system which is strictly regulated and this may not be the best place to change practice. As the result of an administrative reorganisation of the road management in Norway, the 19 different counties now have the authority over most of the secondary road network. These entities do not need to follow national guidelines strictly and may have a more convenient position as client for introducing changes and development.

In Trondheim, there is a major traffic and environment improvement project comprising a tunnel on the secondary road system, called the Byåsen tunnel, which will meet major challenges in the conflict between national regulations (grade, number of tubes, safety installations), rational demands and available funding. Faveo suggests designating this tunnel as a “concept tunnel”. There shall be no relief neither in safety for operation and emergency nor for convenience and maintenance,

but design shall be innovative based on prioritised values and safety shall be based on rational risk analysis in every aspect. Many of those innovative methods and solutions mentioned earlier may become desired concepts e.g. for dialogue in the procurement process.

The key to development still lies with client.

For rail tunnels, there is a paradigm taking place in Norway. Former tunnels did have a minimum of rock support and frost and water insulation, no forced ventilation and double tracks in the same tube if not single tracks. All rail tunnels in Norway are drill and blast. For tunnels on the Intercity systems being built today, there are much higher ambitions for uninterrupted operation, emergency safety and high maximum speed. Even higher ambitions must be the standard if high speed rail is to be introduced in the years to come.

In the opinion of the author, the challenge must not be met with just “more of the same” (bigger sections, more rock support, stiffer lining). And just copying alp tunnels designed for poor rock conditions will not make a rational use of limited funds. There is a potential by thinking differently and to introduce a concept which takes maximum benefit from the latest development of TBM technology, combined rail base and lining slab by watertight and fire proof cast in place concrete, super smooth compact wall and ceiling lining and a range of other innovative solutions.

The key to development still lies with client.

[39] TERN = Trans European Road Network

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**NILSEN, Frode.** MSc Civil Engineering. President construction/mining company, director of the NFF Board and the Chairman NFF International committee. Nilsen has wide experience within underground mining and civil engineering. Areas of operation were mainland Norway, Spitsbergen in the Arctic and abroad.

Address: LNS AS, NO – 8484 Risøyhamn

Tel.: +47.76 11 57 00, Fax: +47.76 11 57 01, e-m: frode.nilsen@lns.no, www.lns.no

**HAUG, Ruth Gunlaug.** MSc Civil Engineering. Project manager. Tunneling experience from National Road Authority and private construction company. Previous president NFF, now active in the NFF International committee.

Address: LNS AS, NO – 8484 Risøyhamn

Tel.: +47.76 11 57 00, Fax: +47.76 11 57 01, e-m: ruth.haug, e-m: ruth.haug@lns.no, www.lns.no

**GRØV, Eivind.** MSc. Prof. II University of Science and Technology in Trondheim (NTNU). Chief Scientist Rock engineering Sintef. Previous Chairman NFF and member of the ITA Exec.Council.

Address: SINTEF Building and Infrastructure Geology and Rock Mechanics, NO-7465 Trondheim

Tel.: +47.73 59 31 76; Fax: +47.73 59 71 36, e-m: eivind.grov@sintef.no www.sintef.no

### Authors

**ARNESEN, Frode.** MSc. Civil engineering.

Address: Stokkamyrveien 13, Inngang Vest, NO - 4313 Sandnes

Tel.: +47.51 22 46 00, Fax: +47.51 22 46 01 frode.arnesen@multiconsult.no

**BEITNES, Anders.** MSc. Faveo Project Management. The author has a life-long experience in civil engineering comprising hydropower, road & rail tunnels and certain aspects of project management, both as CM on the client side, designer, senior advisor and project manager.

**FOSSBERG, Gisle.** MSc Civil Engineering, Head of Contract management section Norwegian Public Roads Administration

Address: P.O.Box 8142 Dep, NO – 0667 Oslo,

Tel.: +47 02030, gisle.fossberg@vegvesen.no www.vegvesen.no

**GRØV, Eivind.** (pls. see above)

**ISLANN, Øystein.** Master of Law. LL.M. Specialized in construction law. Senior contract advisor, public procurement. Experience from project management technical projects, supply chain management, industry and construction contract, advising and monitoring underground construction projects etc.

Address: Jernbaneverket, Eckersbergsgt 4, 3111 Tønsberg, Norway

Tel.: +47 40 43 53 49, isloys@jbv.no

**LUND, Morten.** MSc. Geologist Rock Engineering. Norconsult AS. Wide experience within consultancy for planning, contract preparation, construction control within rock engineering on surface and underground from projects within hydropower, road and railways and industry. During the recent ten years substantial work for the standardisation, e.g. NS 3420 and the related texts took place.

Address: Vestfjordgt.4, NO 1338 Sandvika

Tel.: +47.67 57 10 00, morten.lund@norconsult.com www.norconsult.com

**HANSEN, Jens Petter.** M.Sc. Civil and structural Engineering. Starting with 7 years within contract and construction management in bridge, concrete platforms and hydro power plant projects, from 1997 retained as a consultant in Statoil's Onshore procurement and contract department, joined Statoil 2005 working with contract management in larger civil onshore construction projects, today Principal Consultant Strategic Procurement within Department for Onshore Cessation and Pipeline projects in Statoil.

Address: Statoil ASA, Kårstø, Norway

Tel: +47.48223064, e-mail: konjph@statoil.com www.statoil.com

**HENNING, Jan Eirik.** MSc. Civil Engineering. Project implementation, wide experience in tunneling and rock support. Expert advisor Roads Authority

Address: P.O.Box 8142 Dep, NO – 0667 Oslo,

Tel.: +47 02030, jan.eirik.henning@vegvesen.no

**KAASEN, Knut.** Professor at the Scandinavian Institute for Maritime Law, University in Oslo. Previously, Assistant District Judge, Dean of The Law Faculty, Oslo, Acting Justice, the Norwegian Supreme Court . Also engaged in dispute resolution methods, specifically mediation (including project integrated mediation –PRIME). Moderator in negotiations between construction industry and oil companies / owners to establish agreed standard contracts for offshore and onshore development projects. Arbitrator and mediator in commercial disputes. Frequently lecturing within his field of work.

Address: Domus Media Karl Johans gate 47, POB 6706 St. Olavs plass, NO- 0130 OSLO

Tel: +47.22 85 97 73, Fax +47.22 85 96 10 , knut.kaasen@jus.uio.no , www.uio.no

**KORSVOLD, Jon.** M.Sc. Civil and structural Engineering. Starting with 7 years as a consulting engineer joined Norsk Hydro 1984, from 2007 onwards Statoil. Majority of work in major development projects, primarily for the oil and gas industry. Currently Korsvold holds the position as Leading advisor civil and structural within Statoil.

Address: Statoil ASA, 0246 OSLO, Norway

Tel: +47.91840691, e-mail: jokor@statoil.com www.statoil.com

**NORDAHL, Neal Alexander.** MSc Civil engineering. Degrees from Norway and US. Post training in management and related topics. Wide experience from construction with emphasis on contracts. Hands-on construction management within industry, communication, hydropower. Employed by Veidekke ASA (16 years and still) in the capacity of resident manager, regional and project manager. and on-shore oil facilities and.

Address: P.O.Box 504, NO – 0214 Oslo

Tel.: +47.21 05 50 00, Fax. +47.21 05 50 01 neal.nordahl@veidekke.no www.veidekke.no

**PEDERSEN, Ann.** MSc. Project manager heavy construction underground work, previously manager on behalf of Owner/Developer and Public Service covering small and large projects

Address: c/o LNS Spitsbergen AS, POB 534, NO-9171 Longyearbyen.

Tel: +47.79 02 49 55 and +47.97 50 12 19, ann.pedersen@lns.no www.lns.no

## Editorial Work

**RAVLO, Aslak.** MSc. Previous president and secretary of the Society. Member NFF International Committee. Professional background in design, construction and contract management. Experience surface and subsurface heavy construction. Assignments within major companies in Norway and abroad.

Address: P.O.Box 245, NO -1319 BEKKESTUA,

Tel.: +47 67 14 13 34, a-ravlo@online.no

**SKJEGGEDAL, Thor.** MSc. Secretary of the Norwegian Tunnelling Society. Owner of Skjeggedal Construction Services AS, consultant underground engineering in Norway and abroad. Specialized in tunnelling by TBM and heavy construction in general. Wide contractual and technical experience.

Address: Utsiktsveien 18A, NO - 1369 STABEKK, Norway

Tel.: +47 67 10 57 66, Mobile: +47 913 44 190, thor@skjeggedal.com, www.skjeggedal.com

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