International Symposium
Practices and Trends for Financing and Contracting
Tunnels and Underground Works
Athens, Greece, March 22 - 23

New railway link trough the Alps (NRLA) – The Swiss approach for financing and contracting large tunnel railway infrastructure projects

Heinz Ehrbar
Vice Chairman
Swiss Tunnel Holding Ltd, Esslingen, Switzerland
heinz.ehrbar@swisstunnelholding.com

1 Tunnelling in Switzerland and the NRLA-Concept

The first tunnel in Switzerland has been constructed 1707/1708 in the Gotthard Region. Pietro Morettini, a master builder from the Maggia Valley finished his work for the 64 metres long tunnel in August 1708, 8 months ahead of the schedule. Nevertheless, there was frustration for Morettini because his final costs of 3080 Thalers were almost twice as much as the contract sum of 1680 Thalers. The client, the local people of the Uri-region took the decision to pay Morettini additional 1400 Thalers as a „tip". With this project the long history of Swiss tunnelling started.

In the 19th century many railway tunnels were constructed among them the 15.0 km long Gotthard Tunnel (1870 - 1882), the 19-km-long Simplon Tunnel (1898–1905, 1912–1921) and the 14.6 km long Lötschberg Tunnel (1906 – 1913). The Gotthard Tunnel and the Simplon Tunnel were the longest railway tunnels of the world when they were opened.

During the energy crisis after the First World War, hydropower started to replace coal. The construction of hydropower tunnels became more important than the construction of railway tunnels. In the nineteen-fifties and -sixties, huge hydropower systems with long free-flow and pressure tunnels, shafts and caverns were constructed. Hundreds of kilometres of hydro tunnels were excavated.

In parallel the construction of the Swiss national highway system began at the end of the nineteen-fifties. Road tunnels became the most important underground construction work of the outgoing twentieth century. At the beginning of this century a renaissance of the railway occurred. New railway tunnel were constructed. Since the nineteen-fifties 200 km tunnels and more have been constructed in Switzerland per decade (see Fig. 1).

Swiss Tunnel Holding Ltd.
Bachweg 3
CH-8133 Esslingen/Switzerland
phone +41 44 986 21 21
fax +41 44 986 21 20
Mobile +41 79 349 60 91
heinz.ehrbar@swisstunnelholding.com
www.swisstunnelholding.com

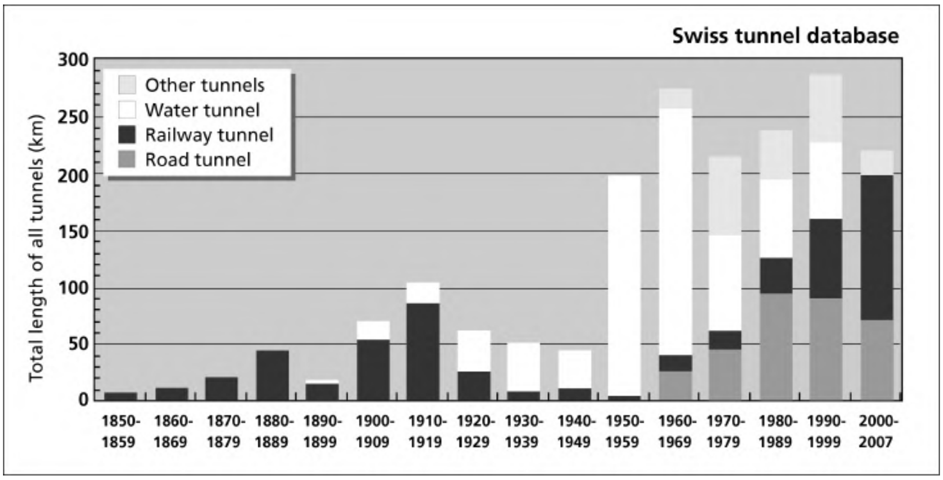

Fig. 1: Underground construction in Switzerland

In 1992 the Swiss voters took the decision to realise the **N**ew **R**ailway **L**ink through the Swiss **A**lps (NRLA) with the Gotthard Axis and the Lötschberg Axis with the aim to improve the 100 years old railway infrastructure in the north-south direction. This new railway infrastructure shall allow more and faster passenger and freight trains. The railway shall become more competitive against the road traffic. A high percentage of the transalpine freight traffic shall be shifted from the road to the rail.

1994 the preliminary work and in 1998 the main work started. The 34.6 kilometres long Lötschberg Base Tunnel has been completed in 2007 and is under successful operation since then. The 57 kilometres long Gotthard Base Tunnel and the 15 kilometres long Ceneri Base Tunnel are still under construction. Over 90 per cents of the civil work of the Gotthard Base Tunnel, the world's longest railway tunnel is completed by end of March 2012. The Gotthard Base Tunnel will be operational at the end of the year 2016 and the Ceneri Base Tunnel in 2019.

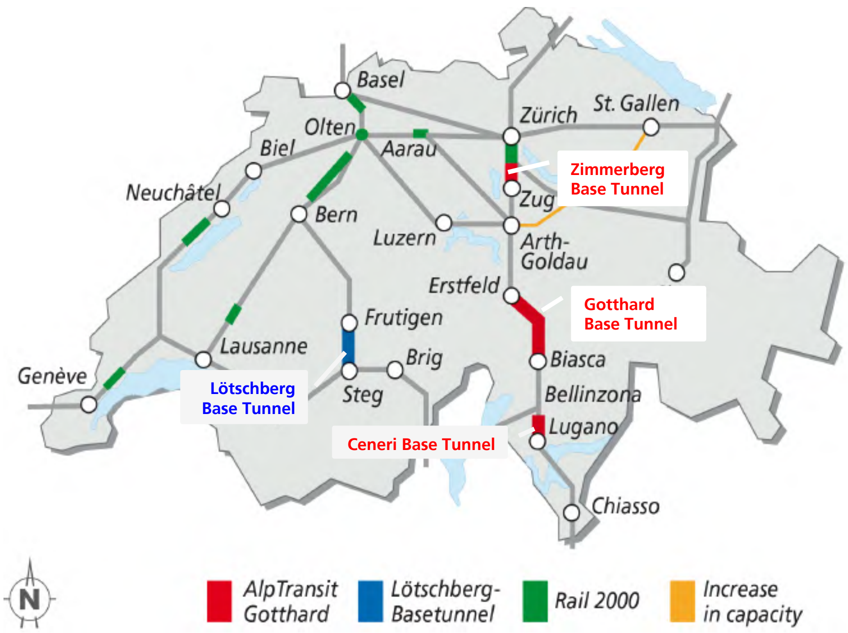

Fig. 2: New railway lines in Switzerland (© AlpTransit Gotthard Ltd.)
AlpTransit Gotthard and the Lötschberg Base tunnel form the NRLA Project

2 Financing of the large railway infrastructure projects

1996, four years after the vote on the NRLA-project big discussions about the financing of the new railway projects (see Fig. 2) with a total investment of 25 billion € started at the level of the federal government. As a result of these discussions the federal government created a new, stable financing model.

In the year 1998 the Swiss voters approved this new financing model in two separate historic votes. In the first vote on a new "heavy road vehicle tax" (LSVA) was accepted as the main financing source (65% of the investments) with a majority of 57.2%. In a second vote the financing of the public railway infrastructure (FinöV) with a new, independent fund was approved (see Fig. 3) with a majority of 63.5%.

The income of the fund is created by of the following sources:
- A new heavy road vehicle tax (65%)
- Part of the existing mineral oil tax (25%)
- New additional 0.1% of the value added tax (10%)

The earnings will be invested in the following projects (see Fig. 1):
- New rail link through the Alps (45%)
- Project "Rail 2000" (44%)
- High-speed rail links to neighbour countries (4%)
- Noise abatement of the railway net (7%)

These public decisions opened the door for the construction of the NRLA-project. High financing costs could be avoided thanks to the financing of 75% of the investments by new or already existing taxes. 25% of the total investment should be financed by credits from the financial market. The future operators had the obligation to pay these credits back. The lifetime of the fund (until all depths will be paid back) was estimated to 23 years from 1997 until 2020.

At the beginning of the construction work the fund was empty. The initial investments increased faster than the income of the fund. Therefore federal treasury gave a loan, which was limited to 3.5 billion €.

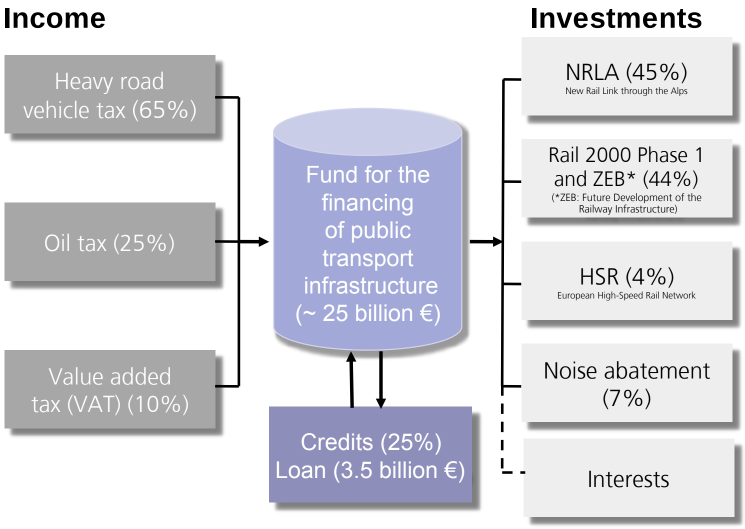

Fig. 3: Financing of the public railway infrastructure with a separate fund (concept 1998)

Higher technical and safety requirements, unforeseen ground conditions; political obstacles and the market situation caused additional costs and an increase of the potential final costs. In 2005 the excavation work of the Lötschberg Base Tunnel was completed and nearly 50% of the total length of the tunnel system of the Gotthard Base Tunnel was excavated. It was the moment for a review on the fund management. As a result of this review several changes in the financing model were maid:

1. The future operators were released from their obligation to pay back the credits of 25% of the total investment.
2. The initial loan limit of 3.5 billion € by the federal treasury was increased up to 8.4 billion €.
3. The lifetime of the fund was extended by 7 years to the year 2027
4. Certain elements of the NRLA-Project such as the 10 kilometres long 2nd phase of the Zimmerberg Base Tunnel close to Zurich were shifted to future financing models in order to guarantee the total final costs of 25 billion €.

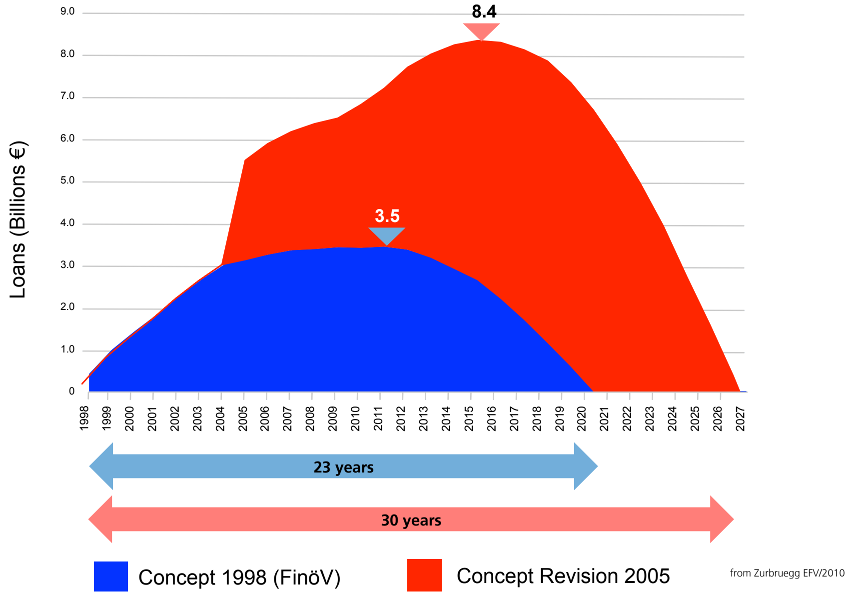

Fig. 4: Management of the fund for the financing of the railway infrastructure, Concepts 1998 and 2005, [1]

Tab. 1 shows the development of the financing concept from 1998 to 2010. The figures show clearly that some cost elements were shifted from the future operator the taxpayer. The total amount of the loans became higher and the loan had to be given on a longer term. Additional costs for interests occurred therefore. The limits of the chosen concept were achieved.

Figures in billion €	1991	1998	2005	2010
Total Investment	n.a.	**25.4**	**25.4**	**26.8**
Committed earnings				
- 25% of Oil Tax	25%	25%	25%	25%
- 2/3 of heavy road vehicle tax	-	65%	65%	65%
- 0.1% of VAT	-	10%	10%	10%
Credits and loans				
- Refundable credits	75%	25%	-	-
- Cumulated loan	-	3.5	8.4	8.4
- Cumulated Interests	n.a.	2.6	4.2	4.2
Credits paid back until (year)	-	2020	2025	2027

Tab. 1: Development of the financing concept 1991 to 2010, [1]

Tab. 2 shows the profit-loss-account of the fund in the years 2007 to 2010. 2007 is the year of the completion of the Lötschberg Base Tunnel. This is the reason for the reduction of the withdrawals for projects in the following years. In 2010 the withdrawals for projects were nearly equivalent to the committed earnings from the taxes. In the same year the additional loans were more or less equal to the costs for interests. The ratio between the different cost categories will remain more or less stable until 2016, the year of the completion of the Gotthard Base Tunnel. Then the payback phase of the loans and credits should start. The financial planning forecasts the complete payback of the loans and credits for the year 2027.

Figures in million €	2007	2008	2009	2010
Loss				
- withdrawal for projects	1'654	1'349	1'284	1'193
- Interests for loans	208	253	263	271
Profit				
- Committed earnings (taxes)	1'076	1'183	1'193	1'185
- loans	786	420	354	279
Cumulated loans by end of year	6'891	7'311	7'665	7'944
Limit of loans	7'958	8'075	8'160	8'279

Tab. 2: Profit – Loss – Account of the fund 2007 – 2010

The steadily increasing traffic on the railway in the agglomerations of the bigger cities and the big success of the project Rail 2000 ask for additional railway infrastructure in Switzerland in the nearer future.

As the existing financing system has come to its limit, new financing models have to be created. The political discussion on this topic is actually held in Switzerland. The new financing model will be a further development of the actual fund system for the financing of large railway infrastructure projects, which has proved its value until today.

3 Swiss contract model for underground construction

3.1 Introduction

Underground construction is different from any other type of construction, due to the fact, that the construction material, the ground, is often not well known or may change within a short distance. The behaviour of the ground is also a result of the interaction with the construction methods applied. Important residual risks are characteristic for large underground projects. Contract models have to take into account this special situation of underground construction and should allow a fast reaction on changed or unforeseen ground conditions.

Fair risk sharing and partnering are helpful tools to facilitate fast decisions on site. Fair risk sharing between the client and the contractor helps to reduce potential claims and therefore the total project costs. The Swiss contracts follow the widely accepted principle of risk sharing for underground construction work [3], meaning:

1. The ground belongs to the client. Changed ground conditions outside the contractual limits are therefore client’s risk.
2. Means and methods applied for ground conditions within the contractual limits belong to the contractor’s risk sphere.

Beside these special aspects, the realisation of underground works follows generally the state of the art principles of civil engineering as for the construction of other structures also. Therefore many relevant Swiss codes for underground construction are the same as for any other type of construction.

The most important code for contractual aspects of civil works is the generally applicable Code SIA 118, “General Conditions for Construction Work” (1977/1993). Code SIA118 requires in Article 5 a sufficiently clear project, and all information from the investigation of the local conditions. A lack of information is a fault of the client and is a reason for additional payment for the contractor (Art. 58).

A special addendum to the Code SIA 118, the code SIA 118/198 “General Conditions for Underground Construction” (2004) gives many standard solutions for the special items of underground construction contracts [9].

3.2 Partnering

Adversary contract management was characteristic for some important historic tunnel projects in Switzerland. Louis Favre, the contractor of the old Gotthard Railway Tunnel (1872 – 1882) offered not only a very ambitious construction schedule at a low price, he signed also a contract with an unfair risk sharing from a modern viewpoint. Louis Favre died before the final breakthrough. The resulting financial problems from the contract led finally to an important court case. Louis Favre’s heirs became financially ruined.

The big challenges of underground construction can often only be solved if the client and the contractor work intensively together. Modern contracts are therefore based on a fair risk sharing and the principle of partnering. Partnering means the definition of mutual objectives (e.g. the completion of the work in time) and the joint and systematic monitoring of the performance of the working progress.

In the case of deviations from the commonly agreed threshold values, problems are discussed and solved in common meetings on the site. Partnering is a very important and helpful tool for underground construction, where fast decisions are required many times.

Partnering may also be seen as an important risk mitigation measure for the client and the contractor and is a chance to create win-win-situations for the client and the contractor.

3.3 Project delivery method and type of contract

Many different approaches for the project delivery are known, such as

- Design – Bid – Build
- Design – Build (Turnkey)
- Build – Operate – Transfer

The commonly used process in Switzerland is the Design-Bid-Build approach, meaning that the client's engineer is responsible for the tender design and the detailed design. The client, together with his design engineer, carries out the bid (tender) phase. Bids for public projects have to respect the federal law on public procurement [11]. This law allows an open bid, in which any qualified bidder may participate, or a selected bid in which a limited number of pre-selected contractors are invited to bid.

After the project has been awarded, the client's engineer prepares the construction documents and the contractor carries out the construction work. In many cases the design engineer acts also as the client's site supervision. He reviews the progress of the work and issues site instructions, change orders or other documentations necessary for the construction process.

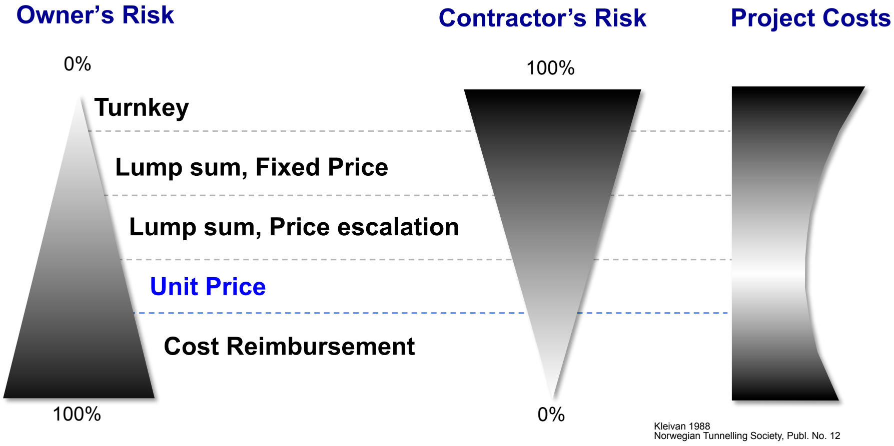

Fig. 5: Relation between contract model, risk sharing and project costs [5]

Based on the Design-Bid-Build project delivery method, the unit price contract is the commonly used type of contract for underground construction in Switzerland. Lump sum contracts are only used in cases with well-known and homogeneous ground conditions. Following the diagram of Kleivan [5] the unit price contract should lead to a contract sum in which either the contractor or the client have to include extended risks. The unit price contract gives a big chance to realise the project at the lowest costs.

3.4 Content of a typical Swiss contract

Swiss contracts for underground construction underwent a big development in the recent years.

Louis Favre signed 1872 a contract of 10 pages with a bill of quantities of 12 pages and a few drawings for the construction of the 15 kilometres long railway tunnel. Modern contracts may consist in 20 volumes and more with thousands of pages and dozens of drawings (see Fig. 6).

The assumption, that shorter contracts are better contracts is wrong if we look at the painful history of Louis Favre (see 3.2).

Fig. 6: Swiss contracts for underground construction (1872 left, 2002 right)

Voluminous contracts need a clear structure. A typical contract for underground construction in Switzerland is embedded in the generally applicable laws and other regulations and has the structure and ranking of the documents as shown in Fig. 7.

Laws, mainly:
Swiss Code of Obligations

1. **contract document**
   including the contract sum, the contract schedule and
   the project specific definition of risk sharing

2. **contractor‘s documents**
   - contractor’s technical report
   - bill of quantities
   - contractor’s drawings
   - Q-agreement

3. **owner’s documents**
   - special conditions
   - design report
   - contract drawings

4. **geological-geotechnical documentation**

5. **relevant codes**
   - general conditions for construction (SIA 118, SIA 118/198)
   - codes for tunnel design and construction (SIA 197/SIA 198)
   - dispute settlement process (VSS 641‘510)
   - other codes

other regulations
health and safety, environmental protection

Fig. 7: Structure and ranking of documents in a typical Swiss underground construction contract

3.5 Most relevant Swiss codes

There are a large number of national codes related to the civil works. Main editor but not only one is the Swiss Association of Engineers and Architects (SIA). The codes shown in Tab. 3 are directly related to the underground construction work. They are divided in codes dealing with the contractual aspects, with the design and construction and with the ground description.

Code SIA 118 “General Conditions for Construction” is the key element in the Swiss codes for construction. This code remained practically unchanged since the last 35 years and has a long period of common practice and interpretations by court decisions. It is applied in all contracts for the construction of civil works.

Code SIA 118/198 is the special addendum to the SIA 118, dealing with the special aspects of underground construction. Chapter 8 of code SIA 118/198 treats the important topic of risk sharing.

The codes SIA 197 (general), SIA 197/1 (railway) and SIA 197/2 (highway) are design codes, whereas code SIA 198 treats the aspects of execution in underground construction.

Code SIA 199 is a recommendation on the description and assessment of the ground conditions for underground works. It clarifies definitions and descriptions in reports and drawings and is based on the in civil engineering generally applied concept of hazard scenarios. This code is of high importance related to the risk allocation related to the ground conditions.

Finally the Swiss Association of Road and Traffic Experts (VSS) produced 1998 the recommendation VSS 641’510 on dispute settlement (see 3.9), which is based on the US-experiences with this Alternative Dispute Resolutions (ADR).

Topic	Code No.		Title	Last edition	Language
Contractual aspects	SIA	118	General conditions for construction work	1977/ 1993	g / f / i (e)
	SIA	118/198	General conditions for underground construction work	2004	g / f / e
Design and Construction	SIA	197	Design of tunnels Basic principles	2004	g / f / e
	SIA	197/1	Design of tunnels Railway tunnels	2004	g / f / e
	SIA	197/2	Design of tunnels Road tunnels	2004	g / f / e
	SIA	198	Underground construction Execution	2004	g / f / e
Ground description	SIA	199	Ground description and assessment for underground construction works	1998	g / f
Dispute review board	VSS	641 510	Resolution of disputes	1998	g / f

Tab. 3: Swiss codes related to underground construction (g = German, f = French, i = Italian, e = English)

3.6 Risk allocation

3.6.1 General remarks

Underground construction work is related to important residual risks (see 3.1). The contract has to give a clear allocation of risks for the case they occur. Risk sharing should be fair. None of the contractual partners should carry the entire load of the remaining risks. Risks should be shared to equal portions with the aim to reduce the total costs (see Fig. 5).

from SIA D014
SIA 198 (1995) Einführung in die neue Norm

Fig. 5: Fair risk sharing

3.6.2 Code SIA 118/198, "General Conditions for Underground Construction"

The code **SIA 118/198** [9] gives a **standard solution for risk sharing** for the following topics, unless not otherwise agreed in the contract:

- The general risks (Art. 8.7.2)
- Drill & blast tunnelling (D&B) in rock (Art. 8.7.3)
- Tunnelling with tunnel boring machine (TBM) in rock (Art. 8.7.4)
- Mechanically assisted tunnelling (MSG) in soft ground (Art. 8.7.5)
- Tunnelling using shield tunnelling machine (SM) in soft ground (Art. 8.7.6)

Art. 8.7.2, SIA 118/198 shifts the following **general risks to the client's side**:

- Rock characteristics different from the tender documents, if the deviation lies outside of the contractual limit
- Presence of gas
- Encountering contaminated ground
- Effects on existing structures within the area of influence of the cavity which occur despite proper execution of the work
- Major collapses due to geological conditions and exceptional inflow of water
- Encountering of archaeological remains

According to the same article the following general risks belong to the **risk sphere of the contractor**:

- Rock characteristics different from the tender documents, if the deviation lies within the contractual limits
- Contractually defined services (means and methods).

More detailed information on risk sharing for the different excavation methods can be found in Code SIA 118/198 “General Conditions for Underground Construction” [9].

3.6.3 Code SIA 118,”General Conditions for Construction Work”

Code **SIA 118** gives the general rules how to deal with **exceptional circumstances** (Art. 59) and with the weather conditions (Art. 60) [8].

- Exceptional circumstances are client’s risks if they could not be foreseen or if they hinder excessively the completion of the work.
- Exceptional circumstances are contractor’s risks if they could be foreseen or if they do not hinder excessively the completion of the work.

The definition of the expression “excessively” is crucial in this context. According to the jurisprudence “excessively” means severe hindrance for the contractor with big economic consequences.

3.6.4 Risks related to occupational health and safety

The federal laws, by-laws and the recommendations of the health and safety authority (EKAS and SUVA) define the responsibilities for occupational health and safety. Each partner of the project is responsible for the occupational health and safety of his own employees.

All partners are committed to coordinate their activities on his site. The client has the obligation to ensure this coordination among the partners on his site. Normally the main contractor is the leading partner on the site for health and safety by contractual agreement. He is responsible for the health and safety organisation, the personal protective equipment, the necessary health and safety installations, and the instruction of his own workers, the personnel of the client and its representatives and workers from third parties.

Until today Swiss laws do not know an integral responsibility of the client on health and safety as it is the case in other countries.

3.7 Evaluation of the construction time

The variable ground conditions lead finally in many cases to a variation of the total construction time compared to the contractual construction time. A clear regulation has to be given in the contract, how to deal with this variation.

The Code SIA 118/198 gives a standard solution and shows in Appendix C an example [9]. According to this rules, the design engineer gives for each type of structure and excavation method his estimate of the length of each combination of excavation class and support class and/or drillability class (see Tab. 4).

The contractor offers his daily advance rates with his bid for each combination of excavation class and support class and/or drillability class.

The contractual driving time is calculated by the multiplication of the estimated length of each excavation and support class and/or drillability class with the offered advance rate. Additional days for interruptions such as auxiliary construction measures, hindrances from water inflows, etc. are considered in the calculation of the working phase. Finally the holidays are added for the calculation of the total construction time.

During the construction the same procedure is done for the calculation of a virtual construction time for the final payment, based on the excavated excavation and support class and/or drillability classes and the contractor's advance rates.

3.8 Payment

3.8.1 General

The cost of tunnelling (excavation and support) is principally influenced by the following parameters *(SIA 198, Art. 8.4.1)*:

- Type of the structure (tunnel, shaft, cavern)
- Tunnelling method (TBM, D & B, mechanically assisted excavation)
- Excavation class (full face, partial excavation, pilot tunnel)
- Support class (type, quantity and working area of the support measures)
- Workability/drillability of the rock mass (drillability or workability class)
- Stability of the tunnel face (type and quantity of the face support)
- Auxiliary constructional measures (type, scope, location of installation).

In addition there are other circumstances which, depending on requirements, influence tunnelling, such as advance investigation measures, measurements for monitoring during the construction phase and special measures in the event of a water inflow; the presence of gas or high temperatures.

Unit price contracts need detailed bills of quantities with a clear definition of the work of each item. Swiss underground contracts use normally the standard description of the work according to the "Norm Position Catalogue" (NPK). The NPK is a standardised description of work for unit price contracts, taking the SIA Codes into account. The federal law of procurement does not allow including any reserves the estimation of the quantities for public work.

The quantities of each item is measured on site in a daily process and paid with monthly payments by the application of the contractually fixed unit prices. Lump sum prices are fixed in the contract mainly for installations and services.

3.8.2 Excavation and support

The payment of excavation and support are typical aspects of underground construction. The parameters shown in 3.8.1 have a direct influence on the performance rate of a tunnel drive and herewith on the costs of the excavation. The contract has to show clear rules how the contractor will be paid for these variable conditions.

Swiss code SIA 118/198 [9] gives the following standard rules:

- SIA 118/198 classifies the excavation types for tunnels in **excavation classes**:

  A: full-face excavation

  B: top heading and subsequent excavation of bench and invert

  C: divided top heading and subsequent excavation of bench and invert

  D: side headings and subsequent excavation of top heading, core and invert

  E: other partial excavation classes defined by the principal on a project-specific basis.

  Changing from one excavation class to another is paid for separately.

- **Support measures** are paid per measured unit installed (e.g. meters of rock bolts, tons of steel ribs, cubic meters of shotcrete, square meters of meshes etc.) independently from the excavation price.
- Support measures are classified in normally five standardised **support classes** according to the type, quantity and installation area of the support. If there is a need for (e.g. extremely variable ground conditions), project specific support classes can be defined. Support classes vary from a light head protection to a strong support using steel ribs, long rock bolts, spiles and shotcrete.
- The client shows in his tender documents a **matrix of typical combinations of excavation classes and support classes** (see Tab. 4).
- The contractor offers also his **daily performance rates** for each matrix element of support and excavation class.
- The contractor offers his **excavation prices** for all matrix elements and includes all hindrances and his costs for the handling of the technical overbreak in his unit prices. The influence of the chosen tunnelling method, of the systematic auxiliary construction measures and of the support on the advance rate as well as the wear on the excavating tools and tool holders (drill bits, round shank cutter bits, disc cutters, soft ground tools, etc.) are included in the excavation prices.
- In the case of TBM- or shield TBM-drives, there is only one excavation type (full face). A third variable is introduced in the matrix system for **TBM-Drives**, the **drillability class**. The limits of drillability classes must be defined in the contract. The penetration rate is normally the main parameter for the classification.
- The excavation of the rock or soft ground is paid corresponding to the **theoretical volume** for the predefined combinations of excavation and support class.
- If the project provides for a **pilot tunnel** or pilot shaft, it will be classified and paid for separately. This has no influence on the classification of the subsequent enlargement to an excavation class. The removal and disposal of a temporary support with anchors, reinforced shotcrete (reinforcing fibres or mesh) or steel ribs is paid for separately.

	Rock			**Loose rock**	
Tunnelling method	D&B drill and blast	TBM tunnel boring machine	MR mechanically-assisted tunnel-driving in rock	MSG mechanically-assisted tunnel-driving in soft ground	SM shield tunnelling machine
Excavation class	A, B, C, D, E	A	A ,B, C, D, E	A ,B, C, D, E	A
Support class SC	1, 2, 3, 4, 5	1, 2, 3, 4, 5, T	1, 2, 3, 4, 5	-	T
Drillability / Cuttability	-	drillability class x, y, z	workability class x, y, z	-	workability class x, y, z
Auxiliary construction measures **Face support**				Measure a, b, c	
Examples for the description of the excavation items	B 2 D 4 E 5	3 x 2 z 1 y	A 3 x B 2 y C4 z	B/jetting/a D/pipe umbrella/b B/blade shield/c	Hydro-shield/x EPB-shield/x Mixed shield/z

Tab. 4: Matrix for payment (SIA 118/198) [9]

3.8.3 Geologically caused standstills

The costs arising from geologically caused interruptions to tunnelling, as far as these are client's risks (see 3.6) or stoppages ordained by the client are paid for separately. The payment is dependant on the duration of the interruption and the number of employees, who could not be employed elsewhere to cover costs.

3.8.4 Inner lining

The main aspect of payment of the inner lining is the payment of the concrete volume taking into account the concrete volume for filling the overbreak. Article 21.2 of Code SIA 118/198 gives solutions for various cases:

- **for general cases**
  Quantities determined according to actual quantity with a price reduction for the concrete due to the technical overbreak (according to Art. 21.2.3).
- **for regular surfaces (e.g. TBM tunnel-driving)**
  Quantities per running metre according to theoretical profile.
- **for individual components, e.g. foundations, niches**
  Quantities determined according to quantity used, including the overbreak concrete.
- **for smooth or regular surface areas, e.g. underlay concrete or smoothing concrete**
  Quantities determined according to theoretical quantity, overbreak concrete according to the theoretical contact surface of the concrete with the rock face or the support.

Concrete for **geological** overbreak will be paid for separately.

3.8.5 Changed quantities

As the ground conditions may change, also the quantities for excavation, support, inner lining etc. may change.

SIA Code 118/198, Article 8.6.2 settles that all unit prices remain unchanged if the bill of quantities includes special items for the site equipment and installations, including prices for a prolongation or a reduction of the construction time.

In the case of a higher demand on support measures the total amount of support measures will lead to a classification in a higher support class. The corresponding excavation price, which includes the bigger hindrance of the excavation by the higher amount of support measures, increases according to the contractor's bid.

Additional construction time will be paid for according the rules shown in Chap. 3.8.6.

3.8.6 Time dependent costs

The contractor is normally paid with lump sums for his various installations and services for the entire contractual construction time. Unit prices for deviations of the construction time are normally fixed in the contract by means of monthly rates for the case of en prolongation of the construction time, but also for the case of a reduction of the construction time (negative unit price).

The contractor's final payment is done for the virtual construction time and not for the effective time he needed (see 3.7). This virtual construction time is the construction time, which the contractor would have needed for the encountered ground conditions, if his performance had been exactly according to the contractual performance rates. Deviations from the contractual performance rates are the contractor's risk as long as the ground conditions are within the contractual limits.

3.9 Dispute settlement

In large Swiss contracts for underground work (mainly in the NRLA-Project), dispute settlement has become common in the last decade. The dispute settlement process according to Code VSS 641'510 follows the steps shown in Fig. 8.

A standard dispute review board (DRB) consists of three members, one chairman, one member proposed by the client and one proposed by the contractor. Each partner has to approve the proposition of the other. If the chairman is a lawyer, the ordinary members should be technical or commercial specialists. The DRB follows the site activities with site visits also when there are no disputes.

If a contractual dispute starts on the site, it should be solved on site according to the principles of partnering. In the case of a failure to find a common solution during the site meetings, the client's and the contractor's executive manager will try to find a solution on their level or they will take the final decision on the failure of the negotiations on site in a joint meeting.

In a next step, the claiming party starts the DRB or arbitration process with a written request to the DRB. The DRB gives written recommendations for the solution of the dispute or acts as an arbitration tribunal in previously agreed smaller cases. If both parties accept the DRB's recommendation, the case will be finished with an arbitration agreement.

The case goes to the public court only if one of the two parties or both parties does not accept the DRB-recommendation.

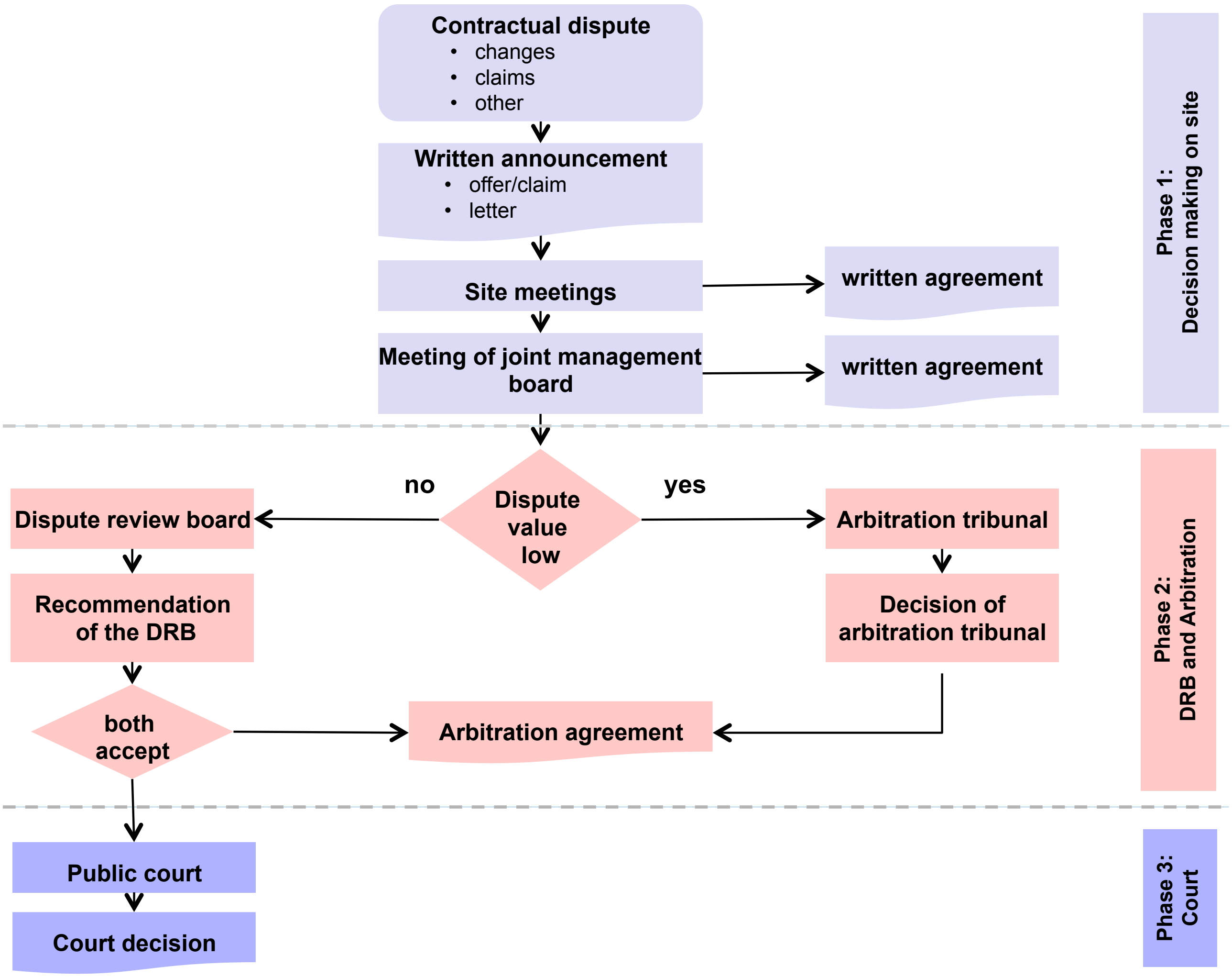

Fig. 8: Dispute resolution process according to the Swiss code VSS 641'510

4 Experiences from the Gotthard Base Tunnel

The final breakthrough of the second tube of the Gotthard Base Tunnel took place on March 23rd 2011. Exactly one year later the inner lining of the tunnel tubes was completed (March 23rd 2012).

After the signature of the main contracts in April 2002 the last breakthrough was expected on October 2008. Due to the difficult ground conditions mainly in the southern part of the tunnel delays of more than 27 months occurred in the contract of the southern side.

The difficult ground conditions caused not only important changes in the time schedule; they caused also additional costs of several hundred million Swiss francs. But not only difficult ground conditions caused changes in the time schedule and the costs. Project extensions, higher safety standards, additional environmental requirements and delays due to political reasons caused a cost increase and had finally to be managed in the contracts.

The experience showed, that variations in the quantities or new unit prices for new activities caused no major problems because of the clear rules in the unit price contracts. Already existing prices remained unchanged (see 3.7.4) and new prices could be agreed using the contractual cost basis.

More difficult was the discussion on the time dependent costs (lump sums). The contract forecasted a variation of the construction period of plus/minus six months. The final prolongation on the southern side was 27 months. New unit prices for the payment of installations, equipment and rear services during the additional construction time had to agreed, based on the cost basis of the contract. After three years of tough negotiations a solution could be found at the end of 2011. With this agreement the last important claim with a main contractor could be settled.

AlpTransit Gotthard Ltd. as the client handles several hundreds of construction contracts, among them 4 contracts with a contract value of several hundred million CHF or more. Until the end of 2011 only 13 cases had to be treated by the DRB and until end of March 2012 no court case with a contractor was pending. This is a remarkable result for an object with investments of 8 billion CHF of civil works.

The physical presence of the DRB was one of the reasons for this result. The site managers felt many times forced to find solutions within their own area of responsibility. The detailed unit price contracts were not an easy, but a powerful tool to solve the problems.

5 Recommendations

The following recommendations can be given based on the experience of more than 20 years of design and construction of the NRLA Projects in Switzerland:

- The purpose of large infrastructure projects must be clear for future clients from the earliest beginning in order to receive the necessary public and political support.
- A stable long term financing model is a must before the beginning of the main work.
- Large projects should be divided in independent construction lots in order to postpone or give up certain elements of the project if there is a need for (“design to cost”).
- Partnering and a fair risk sharing help to find fast solutions in the case of changed conditions and help to reduce the total project costs.
- Unit price contracts give the highest flexibility to react on time on changed conditions. Modern IT-solutions allow the handling of several thousand items in the bill of quantity without problems.
- Time dependent costs must be clearly defined in the bill of quantities. The clients risk analysis has to show the expected variation of the construction time.
- A dispute resolution board (DRB) is of high importance. It helps to reduce disputes, to solve problems on the site and to prevent longtime court cases.

References

[1] Zurbrügg, F., Leisten wir uns ein finanzpolitisches Fass ohne Boden, NRLA-Conference, Federation Infra Switzerland, 2010

[2] Nicollerat, A., Der Fonds für die Eisenbahngrossprojekte (FinöV-Fonds), Schweizer Eisenbahn-Revue 11/2007

[3] ITA Working Group 19, General report on conventional tunnelling, ITA_AITES Report No. 002, 2009

[4] ITA Working Group 3, The ITA Contractual Framework Checklist for Subsurface Construction Contracts, ITA_AITES Report No. 006, 2011

[5] Kleivan, E.: “NoTCoS – Norwegian Tunnelling Contract System”, in Norwegian Tunnelling Today, Publication No. 5, Norwegian Soil and Rock Engineering Association, 1987.

[6] Ehrbar, H., Gotthard Base Tunnel, Switzerland – Experiences with different tunnelling methods, 2º Congresso Brasileiro de Túneis e Estruturas Subterrâneas, Sao Paolo, 2008

[7] Ehrbar, H., Sala, A., Wick, R., Drives in the Gotthard Base Tunnel, Findings and lessons learned from the client’s viewpoint, Swiss Tunnel Congress, Swiss Tunnel Society, 2012

[8] SIA Code 118 (1977/1993), www.sia.ch

[9] SIA Code 118/198 (2004), www.swisstunnel.ch

[10] SIA Code 198 (2004), www.swisstunnel.ch

[11] Bundesgesetz vom 16. Dezember 1994 über das öffentliche Beschaffungswesen (Federal law on public procurement)