Contract Models in underground construction

Experiences from an owner's viewpoint

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Switzerland

Content

- Tunnelling in Switzerland
- Interests and obligations of the contract partners
- Basic principles for contracts in underground construction
- Contract models for underground construction in Switzerland
- Conclusions and recommendations

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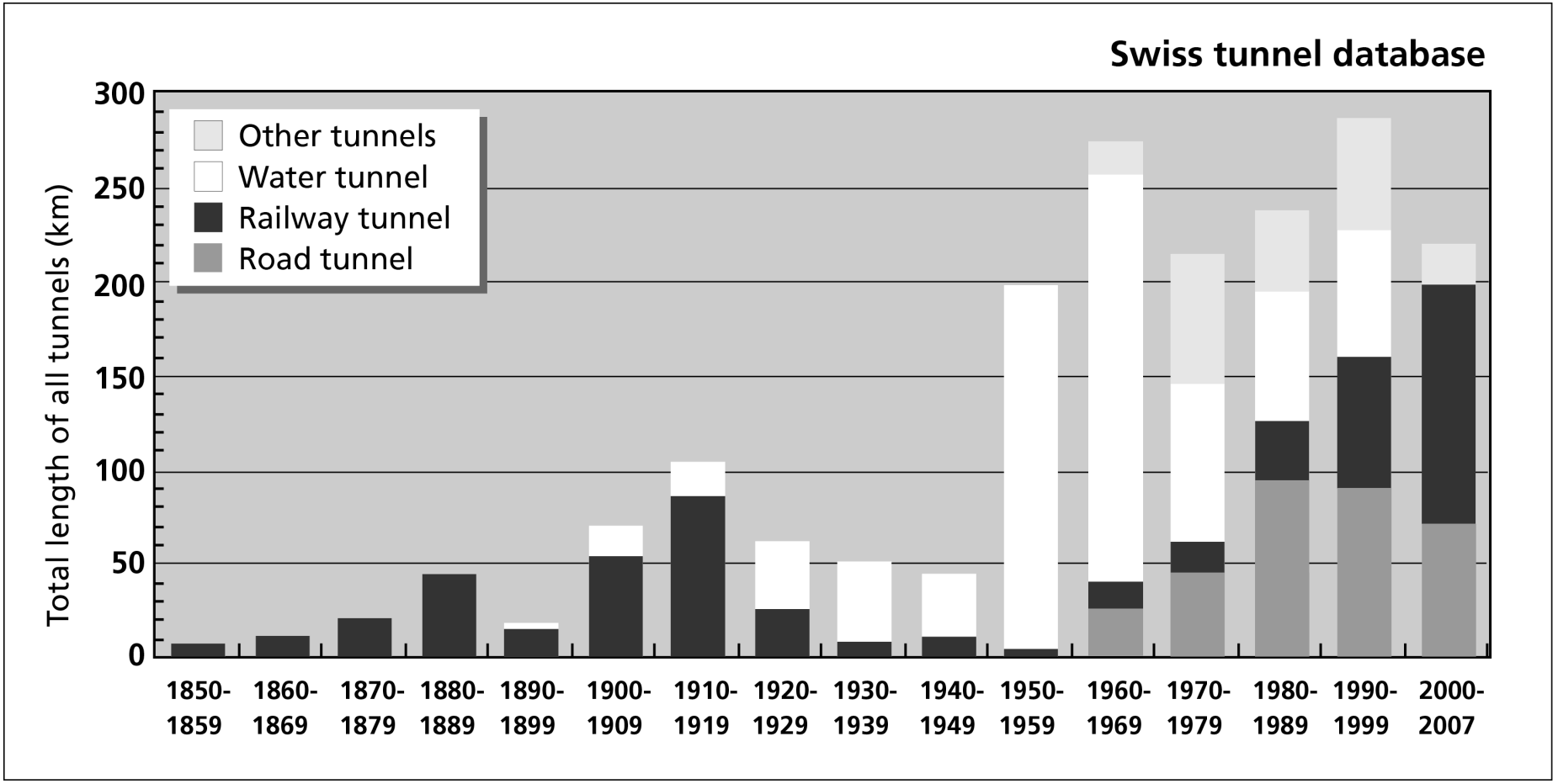
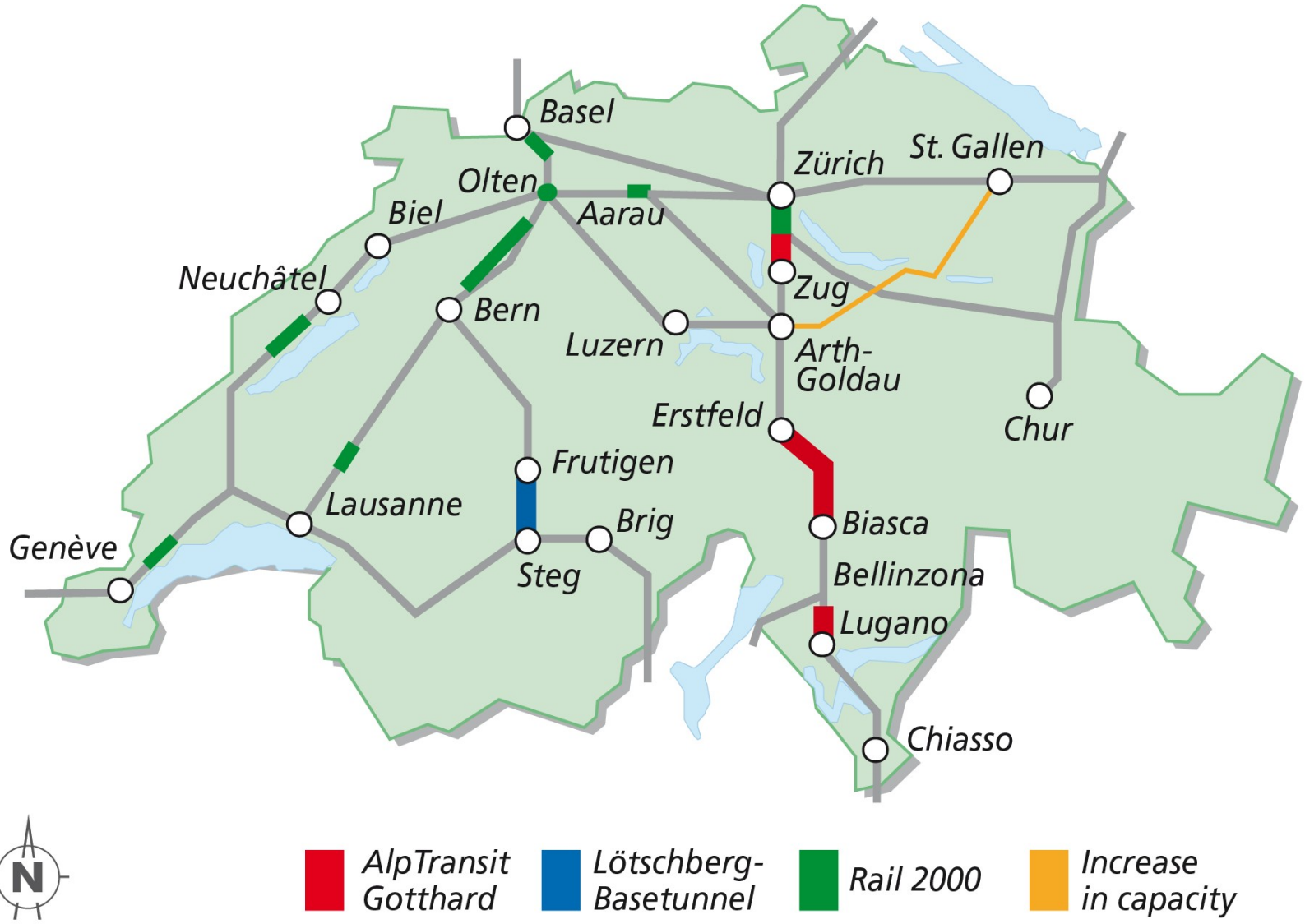
Underground Construction in Switzerland



New Railway Lines in Switzerland

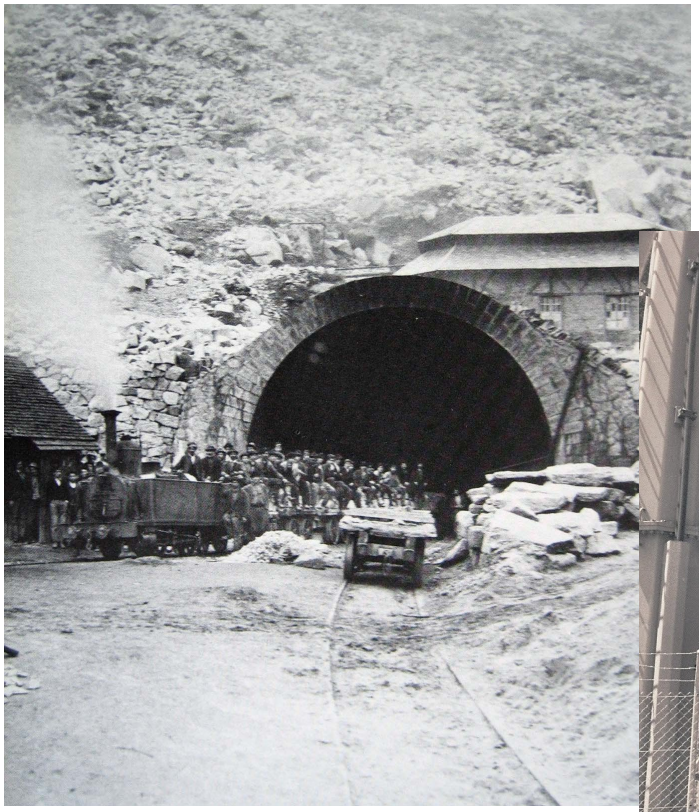


Main projects

Lötschberg Base Tunnel
(34.6 km, completed 2007)

Gotthard Base Tunnel
(57.0 km, under construction)

Important historic projects

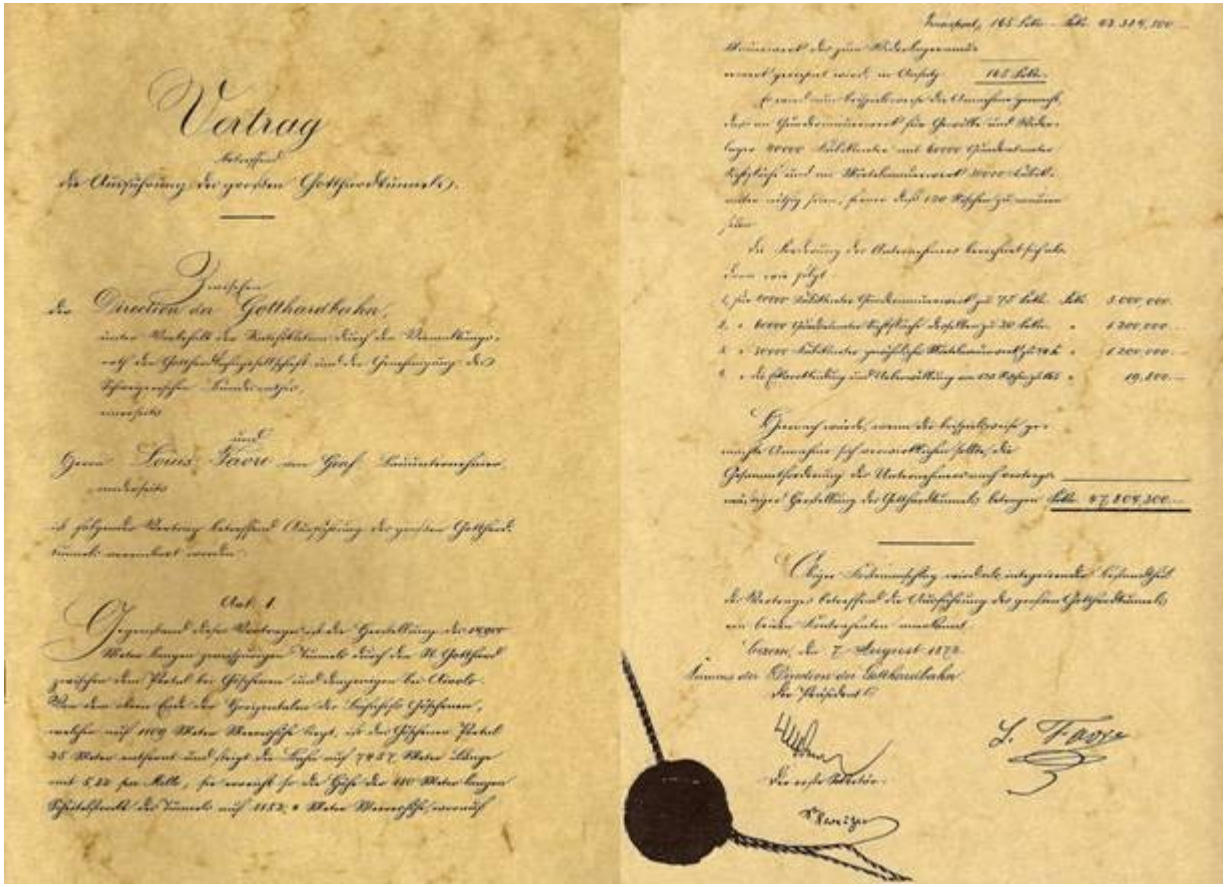


Gotthard Railway Tunnel
(1870 – 1882)

Simplon Railway Tunnel
(1898 – 1921)

Contract for the Gotthard railway tunnel (1872)

Louis Favre
(1826 – 1879)



Vertrag

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Owners view

completion of the work

- within the contractual time schedule,
- with the required quality
- at the lowest costs

Contractor's view

- maximise earnings and avoid losses
- implementing contractors strategies
- employing personnel and using of equipment

Common aims

safe and economical construction

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General principles

- The ground is the construction material
- The ground is often not well known.
- Ground conditions may also change rapidly
- Contracts for underground construction should allow a rapid response to changed ground conditions

Risk sharing / risk allocation

ground belongs to the owner

means and methods
are contractor's risks

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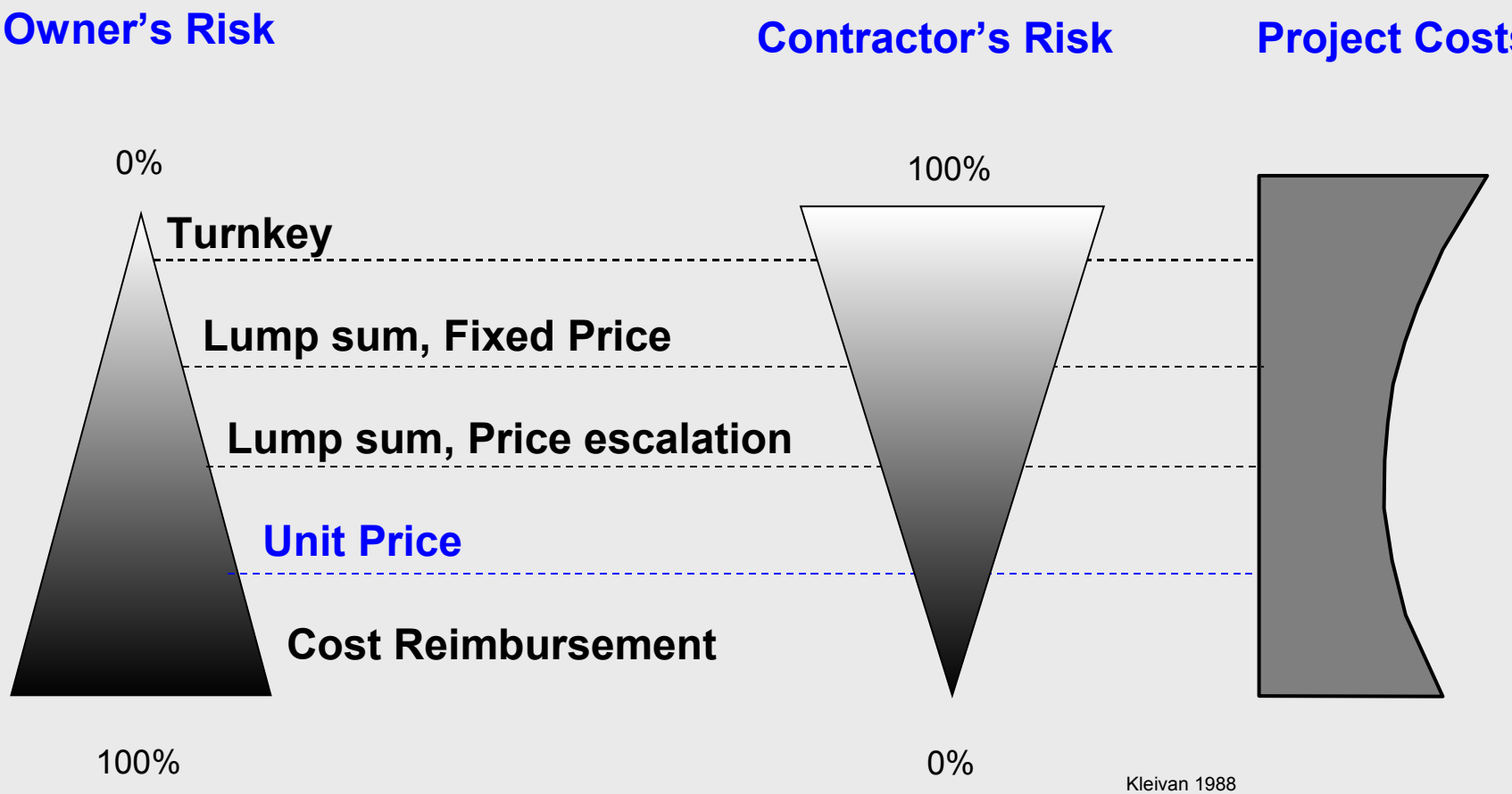
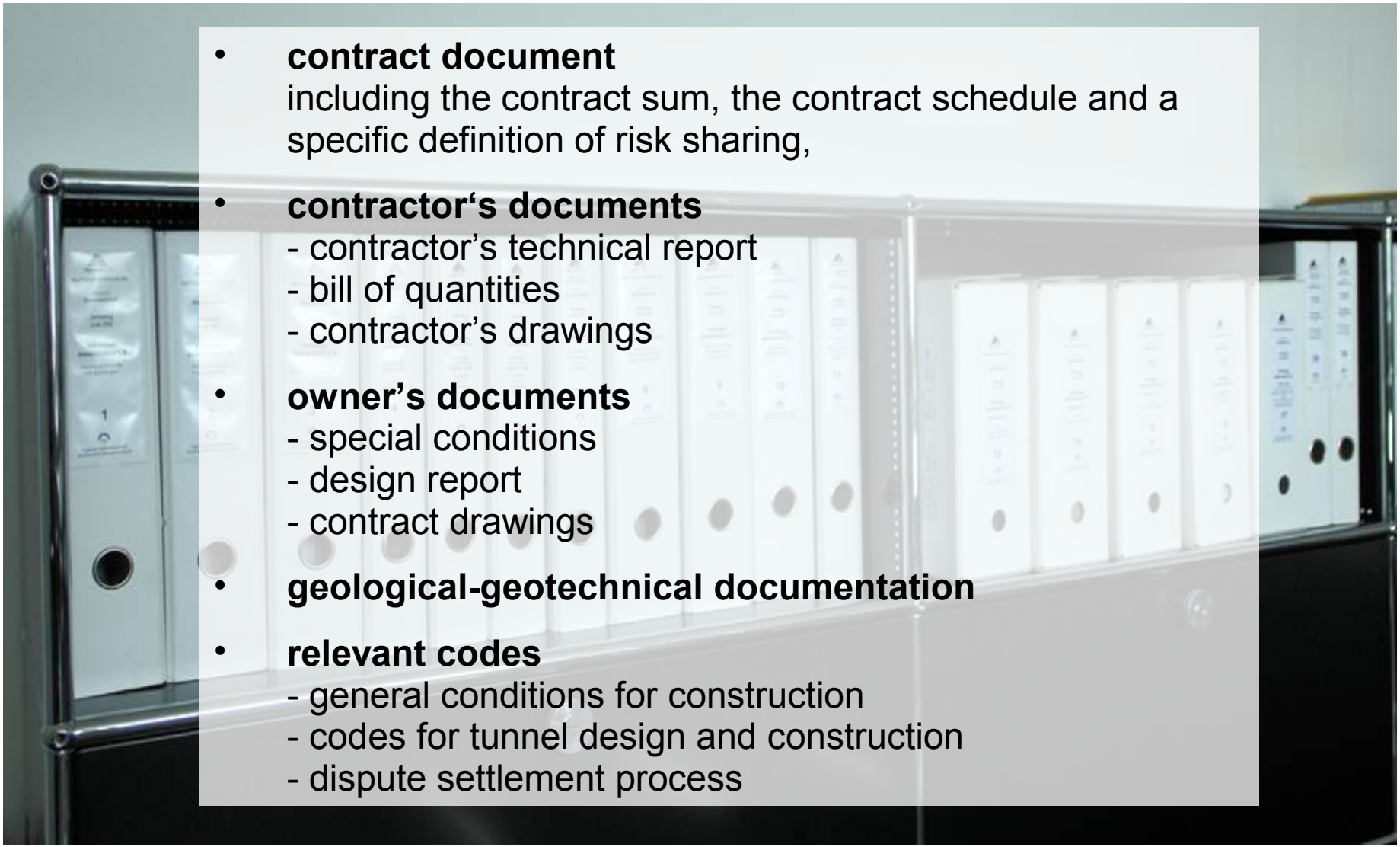
Contract models



Kleivan 1988
Norwegian Tunnelling Society, Publ. No. 12

Contract documents and ranking



- **contract document**
  including the contract sum, the contract schedule and a specific definition of risk sharing,
- **contractor‘s documents**
  - contractor’s technical report
  - bill of quantities
  - contractor’s drawings
- **owner’s documents**
  - special conditions
  - design report
  - contract drawings
- **geological-geotechnical documentation**
- **relevant codes**
  - general conditions for construction
  - codes for tunnel design and construction
  - dispute settlement process

General risk sharing according to the SIA Codes

Owner's risks:

- **changed ground conditions**
- **exceptional circumstances**, which could **not be foreseen** or which, hinder excessively the completion of the works.

Contractor's risks:

- **means and methods for ground conditions** within the contractual limits
- **exceptional circumstances**, which **could be foreseen** or which, do not hinder excessively the completion of the works.

Bill of quantities

Structure of the bill of quantities

• Equipment and services (including operation costs)	global prices
• Excavation	unit prices (acc. to the support classes)
• Support	unit prices
• Dewatering	unit prices
• Drilling and grouting	unit prices
• Impermeabilisation and drainage	unit prices
• Inner lining	unit prices

Special aspects

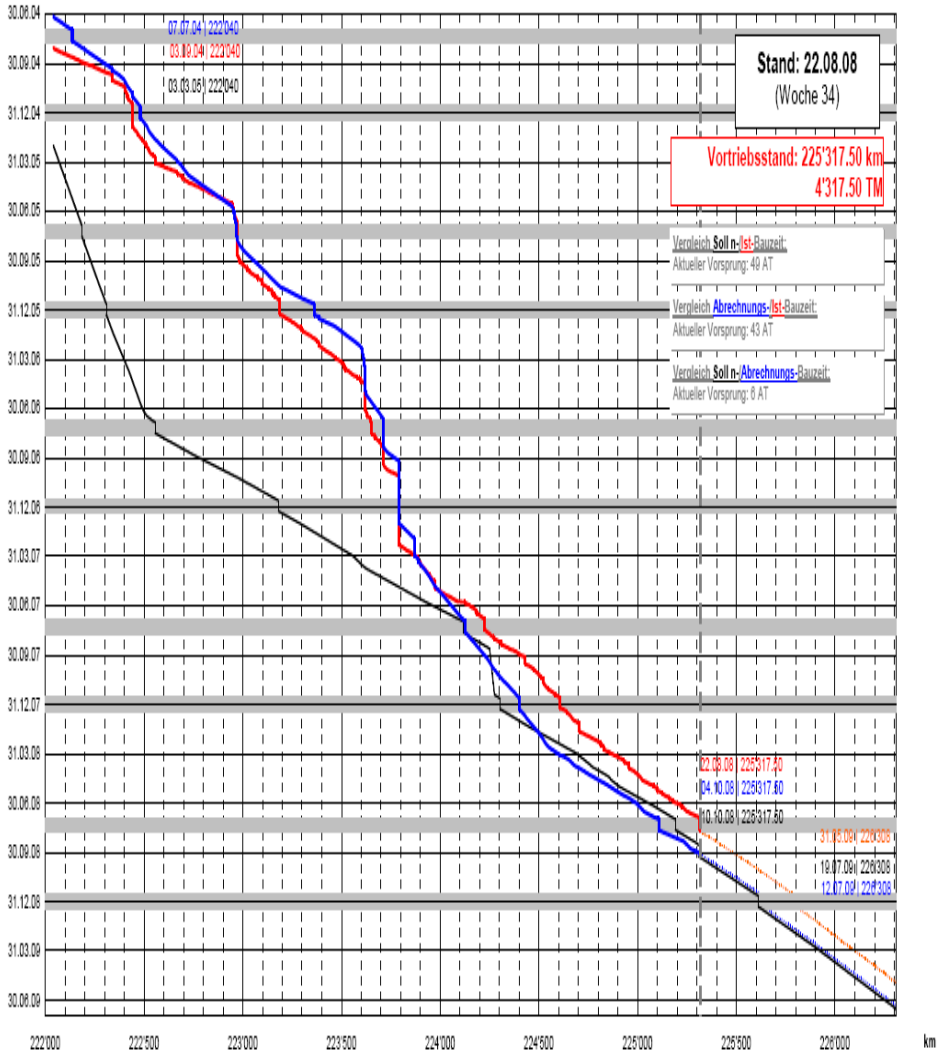
• Overbreak	unit prices (acc. to the risk sharing)
• Additional construction time (if the owner's risk)	global prices (per month)

Changed quantities

The offered unit price remains often fixed in many contracts, independently from relation of the effective quantities to initially estimated quantities.

Construction time

Theoretical construction time, construction time for billing purposes, deadlines			Contract for services **Example 1**			
Component: tunnel			Monthly production time			21
Working phase: drill & blast tunnel-driving, ascending			Interruptions to production time			
Working time: shifts/WD		2	Christmas/New Year			15
Hours/shift		8.5	Summer holiday			10
Category of work	Unit	Unit per WD	Contract Theoretical construction time Quantity	WD	Billing Construction time for billing purposes Quantity	in WD
Tunnel-driving						
SC 1 15 m²	m	5.50	200	36.4	*100*	***18.2***
SC 2 15 m²	m	4.50	350	77.8	*500*	***111.1***
SC 3 16 m²	m	2.50	400	160.0	*330*	***132.0***
SC 4 17 m²	m	1.00	50	50.0	*70*	***70.0***
Total	m	3.09	1000	324.2	*1000*	***331.3***
Interruption of tunnel-driving operations						
Boreholes				4.0		***6.0***
Grouting				3.0		***1.5***
Change of tunnel-driving equipment	hrs		1	1.0		***1.0***
Change of excavation types	hrs		1	2.0		***2.0***
Hindrances resulting from water						
Full-face excavation, ascending	group hrs					
10…20 l/s			1250	14.7	*1800*	***21.1***
20…40 l/s			940	22.1	*800*	***18.8***
40…60 l/s			310	10.9	*400*	***14.1***
Other interruptions						
Various down times				5.0		***10.0***
Collapse Tm 250						***14.0***
support work (subsequent)						***6.0***
Total working phase				386.9		***425.8***
Interruptions to production time						
Christmas/New Year 2002/2003				15.0		***14.0***
Summer holiday 2003				10.0		***10.0***
Christmas/New Year 2003/2004						***15***
Total construction time	in WD			411.8		
	in Mt			19.6		***465.8***
Difference between construction time for billing purposes and theoretical construction time	in WD					***22.2***
	in Mt					***54.0***
Deduction according to section 8.6.10						***2.6***
						-1.0
Extended provision of equipment in Mt						***1.6***
Deadlines Start of work, tunnel-driving phase				15.04.02		*15.04.02*
Completion date, tunnel-driving phase				04.12.03		*26.02.04*



Payment of the excavation: excavation type

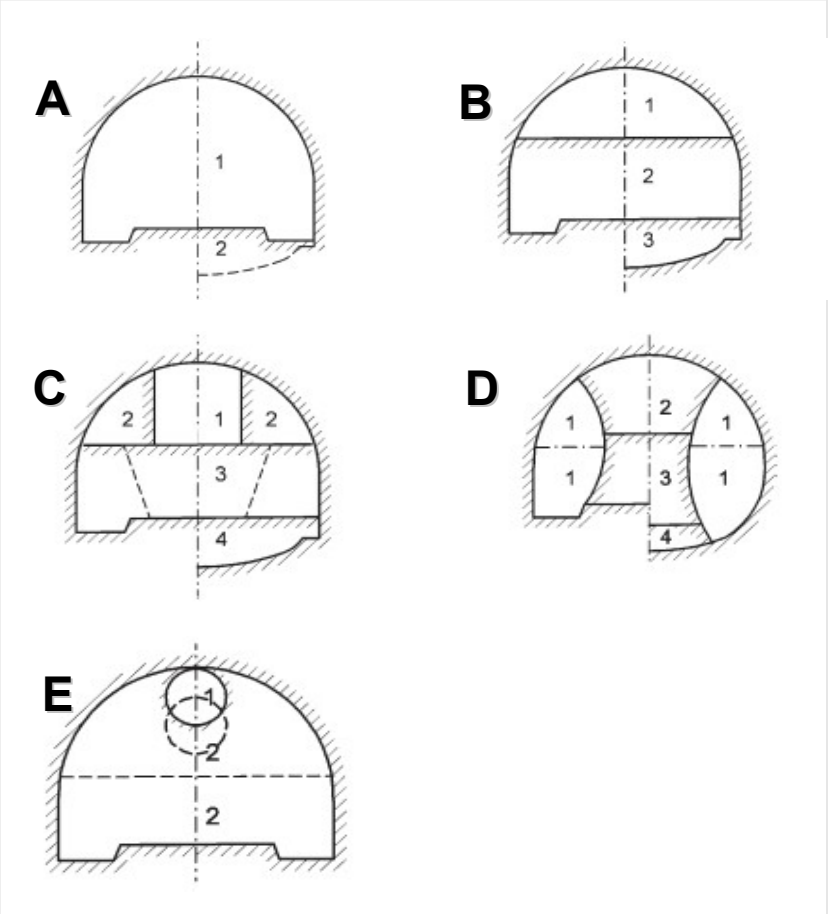
A full face excavation

B Excavation of top heading, then benches

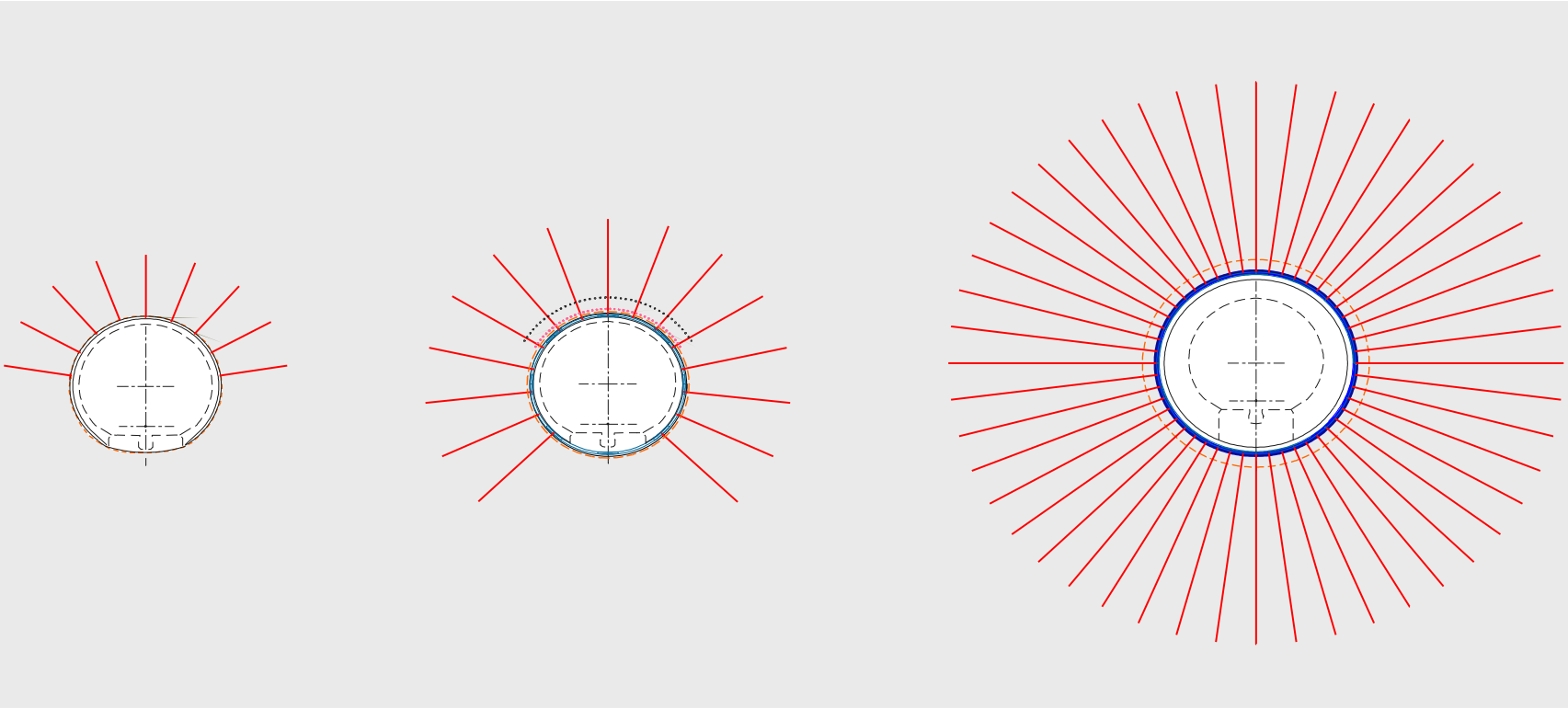
C Excavation of top heading in stages, then benches (in caverns only)

D Side drifts, top heading, core, invert

E Pilot tunnel; enlargement to full section in one stage or partial excavation



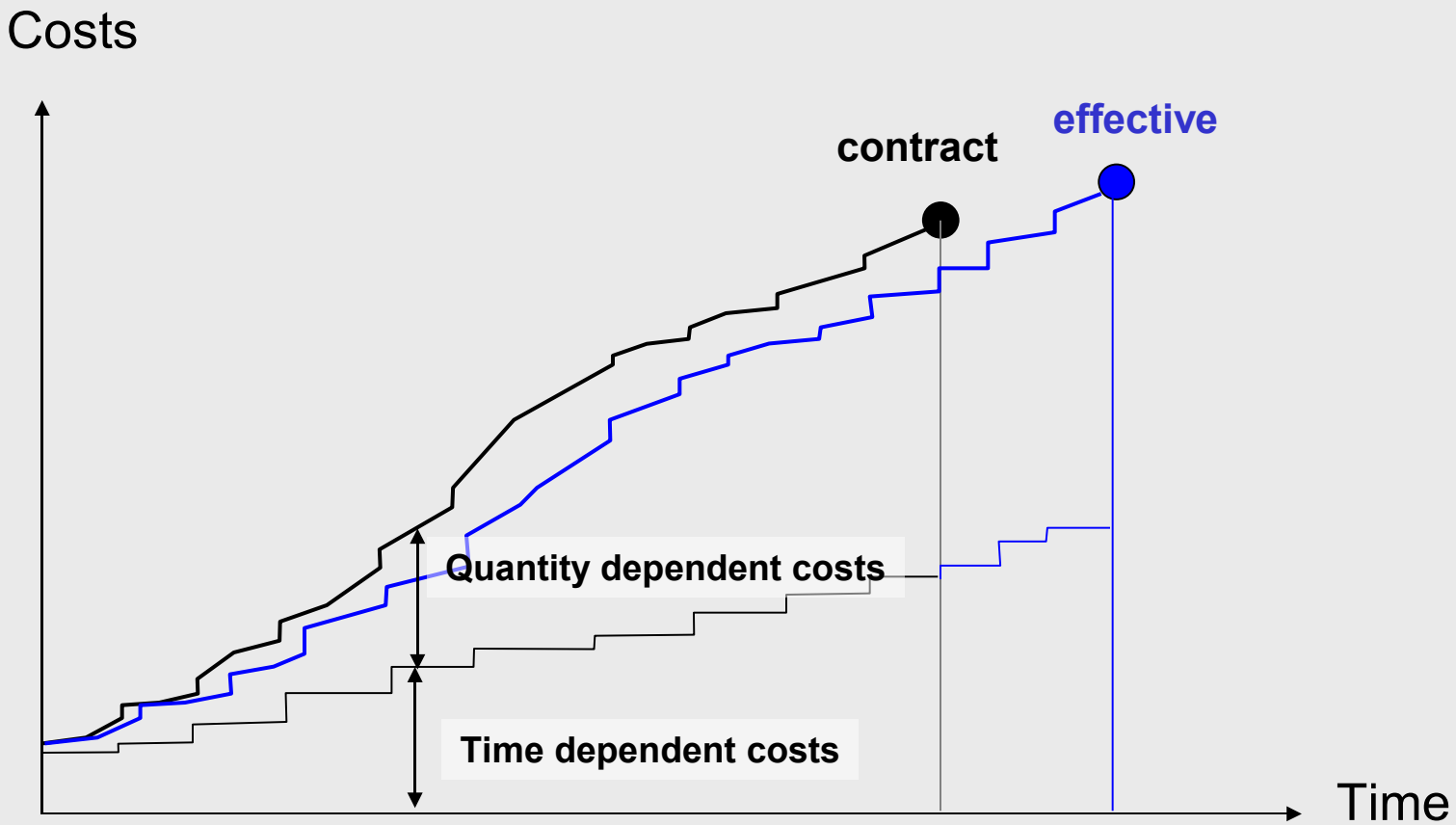
Payment of the excavation: support class



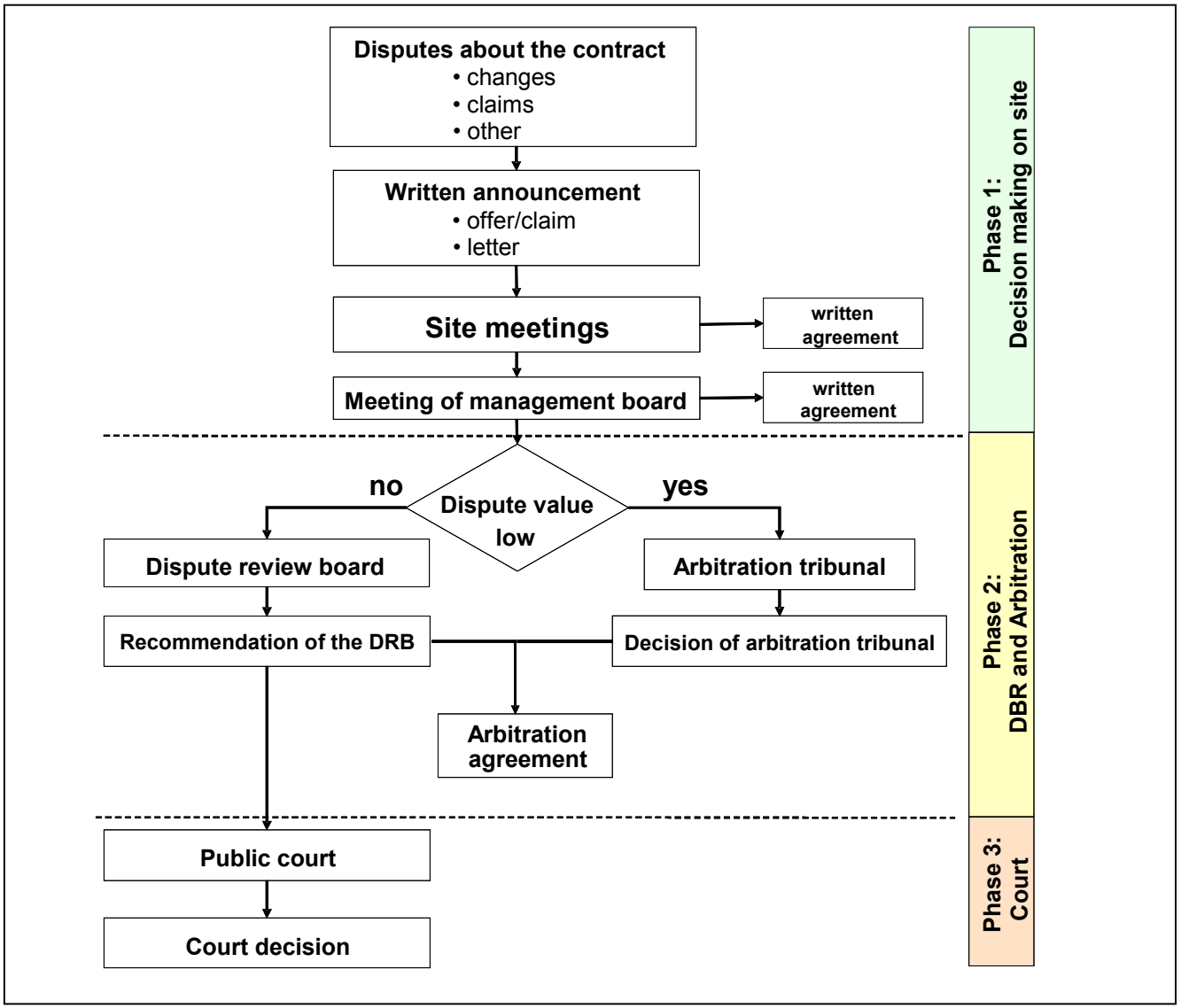
Payment of the excavation

	Rock			Soft ground	
Tunnel-driving method	**Drill and blast**	**TBM**	**MSR** Mechanically-assisted tunnel-driving in rock	**MSG** Mechanically-assisted tunnel-driving in soft ground	**SM** Shield tunnelling machine
Excavation type	A, B, C, D, E	A	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
Excavability	-	Boring class x, y, z	Excavation class x, y, z	-	Excavation class x, y, z
Auxiliary constructional measures, and face support				Measure a, b, c	
Examples of the designation of the excavation items	B 2 D 4 E 5	3 x 2 z 1 y	A 3 x B 2 y C 4 z	B/jet grouting/a D/pipe umbrella/b B/blade shield/c	Hydroshield/x Earth pressure shield/x Mixed shield/z

Payment


Costs
contract
effective
Quantity dependent costs
Time dependent costs
Time

Settlement of disputes



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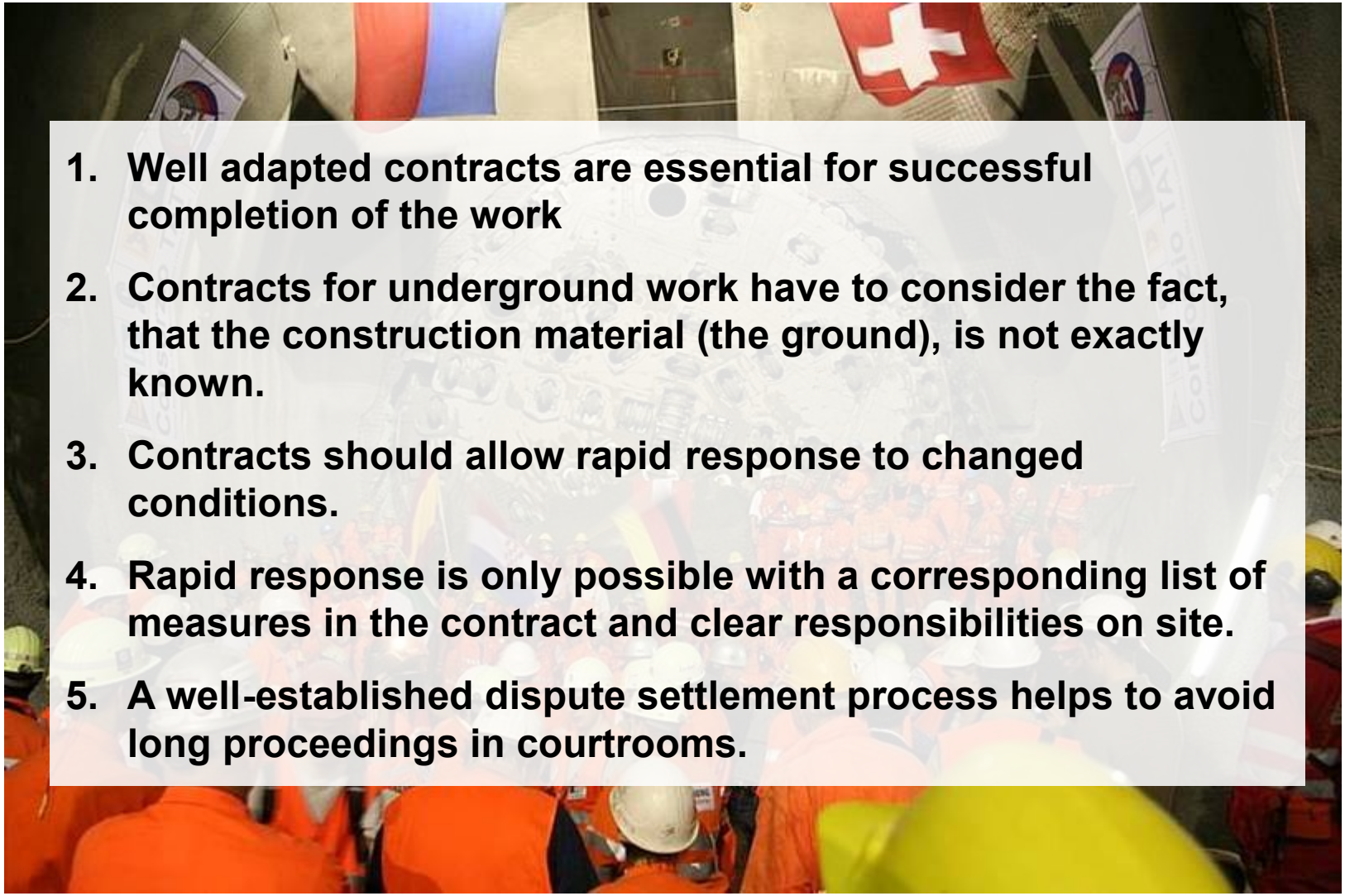
Conclusions and recommendations



1. Well adapted contracts are essential for successful completion of the work
2. Contracts for underground work have to consider the fact, that the construction material (the ground), is not exactly known.
3. Contracts should allow rapid response to changed conditions.
4. Rapid response is only possible with a corresponding list of measures in the contract and clear responsibilities on site.
5. A well-established dispute settlement process helps to avoid long proceedings in courtrooms.


Thank you for your attention!
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