



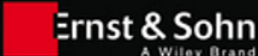
# Handbook of Tunnel Engineering II

## Basics and Additional Services for Design and Construction

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**Bernhard Maidl**  
**Markus Thewes**  
**Ulrich Maidl**

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**B. Maidl, M. Thewes, U. Maidl**

**Handbook of Tunnel Engineering II  
Basics and Additional Services for Design  
and Construction**



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Basics and Additional Services for Design  
and Construction

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**Dedicated to My Grandchildren**

**Maximilian**

**Leon**

**Antonia**

**Frederik**





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## Foreword to the English edition

The “black book of tunnelling” has become a standard work in German-speaking countries since its first German edition in 1984. It can be found on every tunnel site and in every design office – whether contractor or consultant. Students at universities and technical colleges use it as a textbook.

For many years, colleagues from abroad have been asking me for an English edition. Now the time has come to publish the two-volume book in English. An important step was that the publisher of the first German edition, VGE, gave their permission for the publishing of the English edition by Ernst & Sohn, Berlin. Special thanks are due to Dr. *Richter* from Ernst & Sohn for his successful negotiations. However, preparation of the text for the translation showed that the 3<sup>rd</sup> German edition required updating and extending. In particular, the standards and recommendations have been revised. This will all be included in a 4<sup>th</sup> German edition, which will be published soon. Changes to the standards and recommendations are given in this edition, with the references stating the latest version.

As with all books, the English edition has also required the collaboration of colleagues. Professor Dr.-Ing. *Markus Thewes*, who has succeeded me as the holder of my former university chair, and my son Dr.-Ing. *Ulrich Maidl*, managing director of the consultant MTC, have joined me in the team of authors. Dipl.-Ing. *Michael Griese* from MTC is the overall coordinator, assisted by Dipl.-Ing. *Stefan Hintz* from MTC. I thank all those involved, also the translator *David Sturge* and the employees of the publisher Ernst & Sohn in Berlin.

Bochum, in September 2013

*Bernhard Maidl*

Writing without violence is impossible.  
I constantly put myself under pressure.  
Violence is perhaps not the right word.

Daniel Boulanger

## Foreword to the 3<sup>rd</sup> German edition

The above quotation introduced the complete revision of the second volume for the 3<sup>rd</sup> German edition. This became necessary after 15 years because not only the tunnelling technology in the first volume has developed enormously but also the standards and regulations have been revised or harmonised in the European Union. Under these premises, all chapters have been reworked and extended, partly based on my other books like shotcrete, steel fibre shotcrete, shield and TBM tunnelling as well as more recent publications.

The chapter “Dewatering during the Construction Phase” has been extended and is now called “Dewatering, Waterproofing and Drainage” in the second volume; this includes detailed information about hardness stabilisers.

As already in Volume 1, my employees have supported me in every way, although I have also received external help. For example, Dr. *Heimbecher* revised the section about road tunnels in Chapter 1 and Mr *Chromy* contributed to the section about the EU machinery directive in Chapter 8.

I wish to thank them all, and also the collaborators on my former books, which we have referred to for the revision work. Great thanks are also due to the many helpers from the consultancy Maidl + Maidl and for the contributions of several machine manufacturers and the publishers Glückauf.

Bochum, in January 2004

*Bernhard Maidl*

## Foreword to the 2<sup>nd</sup> German edition

The good sales of the “Handbook of Tunnel Engineering” have also accelerated the publication of the second volume. Numerous ongoing and future large tunnel projects lead to a great demand for relevant literature. Reference books about design, tendering and construction are of great importance today, whether for instruction at universities, for practical application in consultancies and on construction sites, but also for the individual engineer interested in gaining further knowledge. So I am personally very satisfied to find the “Handbook of Tunnel Engineering” in use in design offices, on site, and also repeated in the text of university lectures.

On the threshold to the next century, with tunnels becoming ever longer and being constructed under ever more challenging conditions, construction methods are also demanded to comply with ecological, environmental and economic requirements. The necessary development potential covers all construction methods, both in conventional and mechanised tunnelling. The initial requirements, specifically the description of the geology and hydrology with the associated structural verifications and measurements, the environmental requirements, and also the special features of scheduling and cost planning with the associated contractual provisions, are likewise significant factors. This book covers all these subjects.

A complete revision for a new edition would naturally represent the latest state of information, but this is not achievable in the available time. The reader must therefore be asked to consider this when one or other innovation has not yet been included.

I wish to thank the publisher for their processing.

Bochum, in October 1995

*Bernhard Maidl*

**Research and Technology demand ever more Interdisciplinary Knowledge. It is almost a characteristic of our Time that scientific and technical Progress is increasingly taking place at the Interfaces of traditional Professions.**

**Karlheinz Kaske, 1987**

## **Foreword to the 1<sup>st</sup> German edition**

Four years after the publication of the first volume, work on the second volume is at last complete. This Volume II devotes its first chapters to the fundamentals of design, aspects of engineering geology, structural verifications and instrumentation for monitoring with the intention of providing a clear classification of the known theoretical and practical methods. The composition of the chapter “Structural design verifications, structural analysis of tunnels” proved demanding despite the intensive assistance of Herr Dipl.-Ing. *Jens-Detlev Wolter*. Although tunnels are engineering structures, their structural analysis and calculation cannot be undertaken like structures above ground. Their load-bearing behaviour is decisively influenced by the construction method, also including for the tunnel engineer the time factor as construction progresses. This factor is at least as significant as the effect of the rock mass around the tunnel considered as a “construction material”.

The construction method is emphasised in the second volume just as in the first. Construction process technology in tunnelling is a prime example of interdisciplinary research: only an engineer who can master the technical basics of all influential factors can work competently. I could not and did not want to offer a qualitative or even quantitative evaluation of calculation procedures. Experienced structural engineers will form their own opinion. However, construction experience and calculation examples from recent rail, road and underground railway tunnels have been included.

This Volume II also deals with auxiliary works such as dewatering, measurement and control technology and scheduling. The control technology for tunnel boring machines is developing rapidly, particularly for shield machines in different soil types.

Similarly to Volume I, Volume II also includes extensive tables and illustrations in order to represent the idea of a handbook. The examples are taken from numerous newer construction projects.

In the production of this Volume II, I have relied heavily on the assistance of my colleagues at the Institute for Tunnelling and Construction Management. I thank Dipl.-Ing. *Jens-Detlev Wolter*, Dr.-Ing. *Dieter Handke*, Dipl.-Geophys. *Günther Eichweber*, Dr.-Ing. *Harald Brühl*, Professor Dr.-Ing. *Dietrich Stein*, Dipl.-Ing. *Karl-Jürgen Athens* and

Dipl.-Ing. *Jürgen Brenker* for their tireless motivation and months of collaboration, and I particularly wish to thank Dipl.-Ing. *Uwe von Diecken* for the overall leadership of the group. Thanks are also due to Professor Dr.-Ing. *Werner Brilon*, chair of transport I at the Ruhr University, Bochum, for collaboration on Section I.1 in regard to transport technology. I thank my brother Dipl.-Ing. *Reinhold Maidl* for his help and the help of the consultancy, particularly for the assistance with the work load at all times.

I thank the ladies at my chair and the consultancy, Frau *Agatha Eschner-Wellenkamp* and Frau *Hildegard Wördehoff*, and at the drawing office led by Herr *Helmut Schmidt* for their industrious help in the production of the work.

The publisher has assisted me greatly with this volume by looking through the manuscript critically, suggesting improvements and have also presented the work excellently.

Let us hope that Volume II “Basics and Auxiliary Works in Design and Construction” can find its way, as Volume I already has, into the hands of the engineers working for contractors, clients and their supervisors, and not least of the students at the various further education establishments.

Bochum, in May 1988

*Bernhard Maidl*





# Table of Contents

## Volume II: Basics and Additional Services for Design and Construction\*

The authors .....	VII
Foreword to the English edition .....	IX
Foreword to the 3 <sup>rd</sup> German edition .....	X
Foreword to the 2 <sup>nd</sup> German edition .....	XI
Foreword to the 1 <sup>st</sup> German edition .....	XII
<b>1 General Principles for the Design of the Cross-section .....</b>	<b>1</b>
1.1 General .....	1
1.2 Dependence on intended use .....	1
1.2.1 Road tunnels .....	1
1.2.2 Constructional measures for road safety in tunnels .....	5
1.2.3 Rail tunnels .....	7
1.2.4 Construction of rail tunnels .....	12
1.2.5 Underground railway and underground tram tunnels .....	13
1.2.6 Innovative transport systems .....	14
1.2.7 Monorail with magnetic levitation, Transrapid, Metrorapid .....	15
1.2.8 Other underground works .....	15
1.3 The influence of the ground .....	16
1.4 Dependency on construction process .....	19
<b>2 Engineering geology aspects for design and classification .....</b>	<b>21</b>
2.1 General .....	21
2.2 Origin, properties and categorisation of rocks .....	21
2.2.1 General basics .....	21
2.2.2 Categorisation of rocks .....	25
2.2.3 Categorisation of soils .....	25
2.3 Engineering geology and rock mechanics investigations .....	29
2.3.1 Engineering geology investigations .....	30
2.3.2 Rock mechanics investigations .....	33
2.4 The ground and its classification .....	38
2.4.1 Ground .....	38
2.4.2 Classification of the rock mass .....	41
2.4.2.1 General .....	41
2.4.2.2 Basic system of classification .....	41
2.4.2.3 Q System (Quality System) .....	42

\*) The titles of some chapters have changed since their initial announcement in Handbook of Tunnel Engineering, Vol I, with no effect to the content itself.

2.4.2.4	RMR System (Rock Mass Rating System) . . . . .	48
2.4.2.5	Relationship between Q and RMR systems . . . . .	51
2.4.3	Standards, guidelines and recommendations . . . . .	52
2.4.3.1	Classification in Germany . . . . .	52
2.4.3.2	Classification in Switzerland (“Klassierung” according to the SIA standard) . . . . .	57
2.4.3.3	Classification in Austria . . . . .	61
2.4.4	Example of a project-related classification according to DIN 18312 for the shotcrete process . . . . .	68
2.4.4.1	Procedure at the Oerlinghausen Tunnel . . . . .	68
2.4.4.2	Description of the tunnelling classes for the Oerlinghausen Tunnel	70
2.5	Special features for tunnelling machines . . . . .	74
2.5.1	General . . . . .	74
2.5.2	Influences on the boring process . . . . .	74
2.5.3	Influences on the machine bracing . . . . .	76
2.5.4	Influences on the temporary support . . . . .	79
2.5.5	Classification for excavation and support . . . . .	80
2.5.5.1	General and objective for mechanised tunnelling . . . . .	80
2.5.5.2	Classification systems and investigation of suitability for tunnel boring machines . . . . .	80
2.5.6	Standards, guidelines and recommendations . . . . .	84
2.5.6.1	Classification in Germany . . . . .	84
2.5.6.2	Classification in Switzerland . . . . .	88
2.5.6.3	Classification in Austria . . . . .	92
2.5.7	New classification proposal . . . . .	92
<b>3</b>	<b>Structural design verifications, structural analysis of tunnels . . . . .</b>	<b>95</b>
3.1	General . . . . .	95
3.2	Ground pressure theories . . . . .	97
3.2.1	Historical development . . . . .	97
3.2.2	Primary and secondary stress states in the rock mass . . . . .	99
3.2.2.1	Primary stress state . . . . .	99
3.2.2.2	Secondary stress state . . . . .	100
3.3	General steps of model formation . . . . .	100
3.4	Analytical processes and their modelling . . . . .	103
3.4.1	Modelling of shallow tunnels in loose ground . . . . .	103
3.4.2	Modelling deep tunnels in loose ground . . . . .	103
3.4.3	Modelling tunnels in solid rock . . . . .	104
3.4.4	Bedded beam models . . . . .	105
3.5	Numerical methods . . . . .	106
3.5.1	Finite Difference Method (FDM) . . . . .	107
3.5.2	Finite Element Method (FEM) . . . . .	107
3.5.3	Boundary Element Method (BEM) . . . . .	107
3.5.4	Combination of finite element and boundary element methods . . . . .	107

3.6	The application of the finite element method in tunnelling . . . . .	109
3.6.1	“Step-by-Step” technique . . . . .	109
3.6.2	Iteration process. . . . .	109
3.6.3	Simulation of uncoupled partial excavations. . . . .	112
3.7	Special applications of the FEM in tunnelling . . . . .	114
3.7.1	Modelling of deformation slots . . . . .	114
3.7.2	Determination of the loosening of the rock mass from blasting . . . . .	115
3.8	Structural design. . . . .	116
3.8.1	General principles . . . . .	116
3.8.2	Design method for steel fibre concrete tunnel linings . . . . .	118
3.8.3	Conventionally reinforced shotcrete versus steel fibre shotcrete . . . . .	124
<b>4</b>	<b>Measurement for monitoring, probing and recording evidence. . . . .</b>	<b>129</b>
4.1	General . . . . .	129
4.2	Measurement programme. . . . .	130
4.2.1	General. . . . .	130
4.2.2	Measurements of construction states. . . . .	131
4.2.2.1	Standard monitoring section . . . . .	132
4.2.2.2	Principal monitoring sections . . . . .	133
4.2.2.3	Surface measurements . . . . .	134
4.2.2.4	Basic rules for implementation and evaluation . . . . .	134
4.2.3	Measurement of the final state. . . . .	135
4.2.3.1	Measurement programme . . . . .	135
4.2.3.2	Evaluation . . . . .	136
4.2.4	Special features of shield drives . . . . .	136
4.2.4.1	Instrumentation . . . . .	136
4.2.4.2	Recording and evaluation of machine data . . . . .	138
4.2.5	IT systems for the recording and evaluation of geotechnical data . . . . .	146
4.3	Measurement processes, instruments . . . . .	147
4.3.1	Deformation measurement . . . . .	148
4.3.1.1	Geodetic surveying . . . . .	148
4.3.1.2	Convergence measurements . . . . .	148
4.3.1.3	Optical surveying of displacement with electronic total station . . . . .	150
4.3.1.4	Surface surveying . . . . .	151
4.3.1.5	Extensometer measurements . . . . .	152
4.3.1.6	Inclinometer / deflectometer measurements . . . . .	156
4.3.1.7	Sliding micrometer measurements . . . . .	158
4.3.1.8	Trivec measurements . . . . .	159
4.3.2	Profile surveying . . . . .	159
4.3.2.1	Photogrammetric scanner . . . . .	159
4.3.3	Stress and strain measurements in the support layer . . . . .	162
4.3.3.1	Radial and tangential stress measurement in concrete . . . . .	162
4.3.3.2	Measurements in steel arches . . . . .	165
4.3.4	Measurements of the loading and function of anchors . . . . .	165
4.3.4.1	Checking of anchor forces in unbonded anchors. . . . .	165
4.3.4.2	Checking of anchor forces with mechanical measurement anchors . . . . .	167

---

4.4	Geophysical exploration ahead of the face . . . . .	168
4.4.1	Seismology . . . . .	169
4.4.2	Geoelectrical . . . . .	169
4.4.3	Gravimetric . . . . .	169
4.4.4	Geomagnetic . . . . .	169
4.4.5	Geothermal . . . . .	170
4.4.6	Examples and experience . . . . .	170
4.4.6.1	Probing with SSP (Sonic Softground Probing) . . . . .	170
4.4.6.2	Probing karst caves . . . . .	171
4.5	Monitoring and evidence-gathering measures for tunnelling beneath buildings and transport infrastructure . . . . .	178
4.5.1	General. . . . .	178
4.5.2	Monitoring and evidence-gathering measures . . . . .	178
4.5.3	Noise and vibration protection . . . . .	179
4.5.4	Permissible deformation of buildings . . . . .	179
<b>5</b>	<b>Dewatering, waterproofing and drainage . . . . .</b>	<b>183</b>
5.1	General . . . . .	183
5.2	Dewatering during construction . . . . .	183
5.2.1	Water quantity and difficulties. . . . .	184
5.2.1.1	Water flow in the ground . . . . .	184
5.2.1.2	Forms of underground water . . . . .	187
5.2.1.3	Payment and quantity measurement . . . . .	189
5.2.2	Measures to collect and drain groundwater. . . . .	194
5.2.2.1	Measures to collect water . . . . .	194
5.2.2.2	Measures to drain water, open dewatering . . . . .	196
5.2.2.3	Drainage boreholes and drainage tunnels . . . . .	196
5.2.3	Obstructions and reduced performance. . . . .	199
5.2.3.1	General description . . . . .	199
5.2.3.2	Influence of groundwater on the advance rate. . . . .	199
5.2.3.3	Influence of groundwater on tunnelling costs . . . . .	201
5.2.4	Environmental impact and cleaning . . . . .	201
5.2.4.1	Effect on the groundwater system . . . . .	202
5.2.4.2	Effects on groundwater quality . . . . .	203
5.2.5	Sealing groundwater . . . . .	205
5.2.5.1	Grouting process . . . . .	206
5.2.5.2	Ground freezing. . . . .	207
5.3	Tunnel waterproofing . . . . .	208
5.3.1	Requirements. . . . .	210
5.3.1.1	Required degree of water-tightness . . . . .	210
5.3.1.2	Requirements resulting from geological and hydrological conditions. . . . .	211
5.3.1.3	Material requirements . . . . .	212
5.3.1.4	Requirements for the construction process . . . . .	212
5.3.1.5	Requirements for design and detailing . . . . .	213
5.3.1.6	Maintenance. . . . .	214

5.3.1.7	Requirements of the users . . . . .	214
5.3.1.8	Requirements of environmental and waterways protection . . . . .	214
5.3.1.9	Requirements of cost-effectiveness . . . . .	214
5.3.2	Waterproofing concepts . . . . .	215
5.3.2.1	Categorisation . . . . .	215
5.3.2.2	Preliminary waterproofing . . . . .	215
5.3.2.3	Main waterproofing . . . . .	215
5.3.2.4	Repair of waterproofing . . . . .	216
5.3.3	Waterproofing elements and materials . . . . .	217
5.3.3.1	Waterproof concrete . . . . .	217
5.3.3.2	Water-resistant plaster, sealing mortar, resin concrete . . . . .	221
5.3.3.3	Bituminous waterproofing . . . . .	221
5.3.3.4	Plastic waterproofing membranes . . . . .	223
5.3.3.5	Sprayed waterproofing . . . . .	232
5.3.3.6	Metallic waterproofing materials . . . . .	232
5.3.4	Testing of seams in waterproofing membranes . . . . .	233
5.4	Tunnel drainage . . . . .	233
5.4.1	The origin of sintering . . . . .	234
5.4.2	Design of tunnel drainage for low sintering . . . . .	236
5.4.3	Construction of tunnel drainage to reduce sintering . . . . .	239
5.4.3.1	Camera surveys of the pipe runs between the manholes . . . . .	240
5.4.3.2	Data processing and administration . . . . .	240
5.4.3.3	Other quality assurance measures during the construction phase . . . . .	241
5.4.4	Operation and maintenance of drainage systems to reduce sintering . . . . .	242
5.4.4.1	Concepts to reduce maintenance through improvements to systems . . . . .	242
5.4.4.2	Cleaning of drainage systems . . . . .	243
<b>6</b>	<b>New measurement and control technology . . . . .</b>	<b>245</b>
6.1	General . . . . .	245
6.2	Measurement instruments . . . . .	245
6.2.1	Gyroscopic devices . . . . .	245
6.2.2	Lasers . . . . .	249
6.2.3	Optical components for laser devices . . . . .	251
6.2.4	Optical receiver devices . . . . .	252
6.2.5	Hose levelling instruments . . . . .	253
6.2.6	Inclinometer . . . . .	254
6.3	Control in drill and blast tunnelling . . . . .	254
6.3.1	Drilling jumbo navigation . . . . .	254
6.3.2	Determining the position of a drilling boom . . . . .	255
6.3.3	Hydraulic parallel holding of the feeds . . . . .	256
6.3.4	Control of drill booms by microprocessors . . . . .	256
6.3.5	Hydraulic drill booms . . . . .	257

6.4	Control of roadheaders . . . . .	257
6.4.1	Movement parameters determined by the control system . . . . .	257
6.4.2	Roadheader control system from Voest Alpine . . . . .	259
6.4.3	Roadheader control system from Eickhoff . . . . .	264
6.4.4	Roadheader control system from ZED . . . . .	266
6.5	Control of tunnel boring machines (TBM). . . . .	267
6.5.1	General. . . . .	267
6.5.2	Steering with laser beam and active target . . . . .	269
6.6	Steering of small diameter tunnels . . . . .	270
6.6.1	General. . . . .	270
6.6.2	Steering with a ship's gyrocompass. . . . .	271
6.6.3	Pipe jacking steering with laser beam and active target . . . . .	272
6.6.4	Steering with travelling total station . . . . .	273
<b>7</b>	<b>Special features of scheduling tunnel works . . . . .</b>	<b>277</b>
7.1	General . . . . .	277
7.2	Historical overview. . . . .	277
7.3	General planning of tunnel drives . . . . .	281
7.4	Planning tools . . . . .	284
7.5	Control methods . . . . .	285
7.5.1	Control of deadlines. . . . .	285
7.5.2	Cost control . . . . .	286
7.6	Examples of construction schedules. . . . .	287
7.6.1	Construction schedule for the City Tunnel, Leipzig . . . . .	287
7.6.2	Scheduling of rail tunnels through the example of the Landrücken Tunnel and the particular question of starting points . . . . .	289
7.6.3	Scheduling of road tunnels through the example of the Arlberg Tunnel . . . . .	290
7.6.4	Scheduling of inner-city tunnelling through the example of the Stadtbahn Dortmund . . . . .	293
7.6.5	Scheduling of a shield tunnel through the example of Stadtbahn Essen. . . . .	296
<b>8</b>	<b>Safety and safety planning . . . . .</b>	<b>299</b>
8.1	General . . . . .	299
8.2	International guidelines and national regulations. . . . .	299
8.2.1	Directive 89/391/EEC . . . . .	300
8.2.2	Directive 92/57/EEC . . . . .	301
8.2.3	Directive 93/15/EEC . . . . .	303
8.2.4	Directive 98/37/EC . . . . .	303
8.2.5	Implementation into national regulations for blasting. . . . .	305
8.3	Integrated safety plan . . . . .	306
8.3.1	The safety plan as a management plan . . . . .	306
8.3.2	Safety objectives . . . . .	306
8.3.3	Danger scenarios and risk analyses . . . . .	306
8.3.4	Measures plan . . . . .	308

8.4	Transport, storage and handling of explosives . . . . .	309
8.4.1	Transport to the site . . . . .	309
8.4.2	Storage on the site . . . . .	310
8.4.3	Transport on site . . . . .	312
8.4.4	Handling . . . . .	313
8.5	Training of skilled workers. . . . .	316
8.6	The construction site regulations (BaustellV) . . . . .	316
8.6.1	General. . . . .	316
8.6.2	The tools of the construction site regulations . . . . .	318
8.6.3	The health and safety plan (health and safety plan) . . . . .	324
8.6.4	Working steps in the production of a health and safety plan. . . . .	325
8.7	Example of a tender for health and safety protection. . . . .	327
8.7.1	General. . . . .	327
8.7.2	Health and safety concept . . . . .	328
8.7.2.1	Hazard analyses . . . . .	329
8.7.2.2	Fire protection, escape and rescue concept . . . . .	329
8.7.2.3	Health protection concept . . . . .	330
8.7.2.4	Site facilities plans. . . . .	332
8.7.2.5	Concept for traffic control measures inside the site area. . . . .	332
8.7.2.6	Documents with information for later works to the structure . . . . .	332
8.7.2.7	Measures to prevent danger to third parties resulting from the duty to maintain road safety . . . . .	333
<b>9</b>	<b>Special features in tendering, award and contract . . . . .</b>	<b>335</b>
9.1	General . . . . .	335
9.2	Examples of forms of contract . . . . .	335
9.2.1	Procedure in Switzerland. . . . .	335
9.2.2	Procedure in the Netherlands. . . . .	340
9.2.3	Procedure in Germany. . . . .	343
9.3	Design and geotechnical requirements for the tendering of mechanised tunnelling as an alternative proposal . . . . .	343
9.3.1	General. . . . .	343
9.3.2	Examples: Adler Tunnel, Sieberg Tunnel, Stuttgart Airport Tunnel, Rennsteig Tunnel, Lainzer Tunnel . . . . .	344
9.3.3	Additional requirements for mechanised tunnelling in the tender documents. . . . .	350
9.3.4	Costs as a decision criterion . . . . .	352
9.3.5	Outlook . . . . .	353
<b>10</b>	<b>Process controlling and data management . . . . .</b>	<b>355</b>
10.1	Introduction . . . . .	355
10.2	Procedure . . . . .	355
10.3	Data management. . . . .	356
10.4	Target-actual comparison . . . . .	357
10.5	Target process structure . . . . .	359
10.6	Analysis of the actual process . . . . .	361

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<b>11</b>	<b>DAUB recommendations for the selection of tunnelling machines</b>	<b>363</b>
11.1	Preliminary notes	363
11.2	Regulatory works	364
11.2.1	National regulations	364
11.2.2	International standards	365
11.2.3	Standards and other regulatory works	365
11.3	Definitions and abbreviations	366
11.3.1	Definitions	366
11.3.2	Abbreviations	368
11.4	Application and structure of the recommendations	368
11.5	Categorisation of tunnelling machines	370
11.5.1	Types of tunnelling machine (TVM)	370
11.5.2	Tunnel boring machines (TBM)	370
11.5.2.1	Tunnel boring machines without shield (Gripper TBM)	370
11.5.2.2	Enlargement tunnel boring machines (ETBM)	371
11.5.2.3	Tunnel boring machine with shield (TBM-S)	372
11.5.3	Double shield machines (DSM)	372
11.5.4	Shield machines (SM)	372
11.5.4.1	Shield machines for full-face excavation (SM-V)	372
11.5.4.2	Shield machines with partial face excavation (SM-T)	375
11.5.5	Adaptable shield machines with convertible process technology (KSM)	376
11.5.6	Special types	376
11.5.6.1	Blade shields	376
11.5.6.2	Shields with multiple circular cross-sections	376
11.5.6.3	Articulated shields	376
11.5.7	Support and lining	377
11.5.7.1	Tunnel boring machines (TBM)	377
11.5.7.2	Tunnel boring machines with shield (TBM-S), Shield machines (SM, DSM, KSM)	378
11.5.7.3	Advance support	379
11.5.7.4	Support next to the tunnelling machine	380
11.6	Ground and system behaviour	380
11.6.1	Preliminary remarks	380
11.6.2	Ground stability and face support	380
11.6.3	Excavation	381
11.6.3.1	Sticking	381
11.6.3.2	Wear	382
11.6.3.3	Soil conditioning	382
11.6.3.4	Soil separation	383
11.6.3.5	Soil transport and tipping	383
11.7	Environmental aspects	384
11.8	Other project conditions	386



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11.9	Scope of application and selection criteria	387
11.9.1	General notes about the use of the tables	387
11.9.1.1	Core area of application	387
11.9.1.2	Possible areas of application	387
11.9.1.3	Critical areas of application	388
11.9.1.4	Classification in soft ground	388
11.9.1.5	Classification in rock	388
11.9.2	Notes about each type of tunnelling machine	388
11.9.2.1	TBM (Tunnel boring machine)	388
11.9.2.2	DSM (Double shield machines)	388
11.9.2.3	SM-V1 (full-face excavation, face without support)	389
11.9.2.4	SM-V2 (full-face excavation, face with mechanical support)	389
11.9.2.5	SM-V3 (Full-face excavation, face with compressed air application)	389
11.9.2.6	SM-V4 (full-face excavation, face with slurry support)	389
11.9.2.7	SM-V5 (full-face excavation, face with earth pressure balance support)	389
11.9.2.8	SM-T1 (partial excavation, face without support)	390
11.9.2.9	SM-T2 (partial excavation, face with mechanical support)	390
11.9.2.10	SM-T3 (partial excavation, face with compressed air application)	390
11.9.2.11	SM-T4 (Partial excavation, face with slurry support)	390
11.9.2.12	KSM (Convertible shield machines)	390
11.10	Appendices	391
	<b>Bibliography</b>	411
	<b>Index</b>	423

# Table of Contents

## Volume I: Structures and Methods

- 1 Introduction**
  - 1.1 General
  - 1.2 Historical development
  - 1.3 Terms and descriptions
- 2 Support methods and materials**
  - 2.1 General
  - 2.2 Action of the support materials
    - 2.2.1 Stiffness and deformability
    - 2.2.2 Bond
    - 2.2.3 Time of installation
  - 2.3 Timbering
    - 2.3.1 General
    - 2.3.2 Frame set timbering
    - 2.3.3 Trussed timbering
    - 2.3.4 Shoring and lagging
  - 2.4 Steel ribs
    - 2.4.1 General
    - 2.4.2 Profile forms
    - 2.4.3 Examples of typical arch forms for large and small tunnels.
    - 2.4.4 Installation
  - 2.5 Lattice beam elements
  - 2.6 Advance support measures
    - 2.6.1 Steel lagging sheets and plates
    - 2.6.2 Spiles
    - 2.6.3 Injection tubes
    - 2.6.4 Pipe screens, grout screens, jet grout screens
    - 2.6.5 Ground freezing
  - 2.7 Rock bolts
    - 2.7.1 General
    - 2.7.2 Mode of action
    - 2.7.3 Anchor length and spacing
    - 2.7.4 Load-bearing behaviour
    - 2.7.5 Anchor types
  - 2.8 Concrete in tunnelling
    - 2.8.1 General
    - 2.8.2 Construction variants
      - 2.8.2.1 Two-layer construction
      - 2.8.2.2 Single-layer construction

- 2.8.3 Shotcrete
  - 2.8.3.1 General
  - 2.8.3.2 Process technology, equipment and handling
  - 2.8.3.3 Mixing and recipes
  - 2.8.3.4 Influence of materials technology and process technology
  - 2.8.3.5 Quality criteria, material behaviour and calculation methods, quality control
  - 2.8.3.6 Mechanisation of shotcrete technology
  - 2.8.3.7 Steel fibre concrete
  - 2.8.3.8 Working safety
- 2.8.4 Cast concrete
  - 2.8.4.1 Formwork
  - 2.8.4.2 Concreting
  - 2.8.4.3 Reinforced or unreinforced concrete lining
  - 2.8.4.4 Factors affecting crack formation
  - 2.8.4.5 Disadvantages of nominal reinforcement
  - 2.8.4.6 Stripping times
  - 2.8.4.7 Filling of the crown gap
  - 2.8.4.8 Joint details
  - 2.8.4.9 Single-pass process, extruded concrete
  - 2.8.4.10 After-treatment
- 2.8.5 Precast elements, cast segments
  - 2.8.5.1 Steel segments
  - 2.8.5.2 Cast steel segments
  - 2.8.5.3 Cast iron segments
  - 2.8.5.4 Reinforced concrete segments
  - 2.8.5.5 Geometrical shapes and arrangement
  - 2.8.5.6 Details of radial joints
  - 2.8.5.7 Circumferential joint details
  - 2.8.5.8 Fixing and sealing systems
  - 2.8.5.9 Segment gaskets
  - 2.8.5.10 Production of reinforced concrete segments
  - 2.8.5.11 Installation of segment lining
- 2.8.6 Linings for sewer tunnels
- 2.8.7 Yielding elements

### **3 The classic methods and their further developments**

- 3.1 General
- 3.2 Full-face excavation
- 3.3 Partial-face excavation
  - 3.3.1 Bench excavation
  - 3.3.2 The Belgian or underpinning tunnelling method
  - 3.3.3 The German or remaining core tunnelling method
  - 3.3.4 The Austrian or upraise tunnelling method
  - 3.3.5 The New Austrian Tunnelling Method

- 3.3.6 The English tunnelling method
- 3.3.7 The Italian or packing tunnelling method
- 3.4 Classic shield drives
- 3.5 The classic tunnelling machines
  
- 4 Shotcrete tunnelling**
- 4.1 General
- 4.2 Top heading process
  - 4.2.1 Shotcrete tunnelling method
  - 4.2.2 Underpinning method
  - 4.2.3 Crown pilot heading with crown beam
  - 4.2.4 Shotcrete tunnelling with longitudinal slots
- 4.3 Core tunnelling method with side headings
- 4.4 Special processes using shotcrete
  - 4.4.1 Compressed air
  - 4.4.2 Ground freezing, grouting
- 4.5 Shotcrete in mining
  - 4.5.1 Tunnel support
  - 4.5.2 Shaft insets
- 4.6 Outlook for further development
- 4.7 The new Italian tunnelling method (ADECCO-RS)
  - 4.7.1 Theoretical model
  - 4.7.2 Procedure through the example of the new line from Bologna – Florence
  
- 5 Drill and blast tunnelling**
- 5.1 Historical development
- 5.2 Drilling
  - 5.2.1 General
  - 5.2.2 Drills
  - 5.2.3 Drill bits
  - 5.2.4 Wear
  - 5.2.5 Performance
  - 5.2.6 Costs
- 5.3 Blasting
  - 5.3.1 General
  - 5.3.2 Explosives in tunnelling
  - 5.3.3 Detonators and detonation systems in tunnelling
  - 5.3.4 Transport, storage and handling of explosives
  - 5.3.5 Charge determination
  - 5.3.6 The drilling and firing pattern
  - 5.3.7 Charge loading
  - 5.3.8 Time calculation
  - 5.3.9 Blasting technology aspects

- 5.4 Mucking
  - 5.4.1 General
  - 5.4.2 Loading machines
  - 5.4.3 Muck conveyance
  - 5.4.4 Output of transport vehicles
  - 5.4.5 Examples of transport chains
  - 5.4.6 Further developments
- 5.5 Combination of drill and blast with mechanised tunnelling processes
  - 5.5.1 Combinations with roadheaders
  - 5.5.2 Combination with full-face machines
- 5.6 Effects of blasting on the surroundings
  - 5.6.1 Vibration
  - 5.6.2 Composition and effects of the blasting gas emissions
- 5.7 Mechanisation and Automation
  - 5.7.1 General
  - 5.7.2 Emphasis of mechanisation
  - 5.7.3 Computer-assisted drill jumbos
  - 5.7.4 Mucking and tunnel logistics
- 6 Mechanised tunnelling**
- 6.1 General
- 6.2 Categories of tunnelling machines
- 6.3 Shield machines
  - 6.3.1 Categories of shield machines
  - 6.3.2 Basic principle, definition
  - 6.3.3 Face without support
  - 6.3.4 Face with mechanical support
  - 6.3.5 Face under compressed air
  - 6.3.6 Face with slurry support
    - 6.3.6.1 Functional principle
    - 6.3.6.2 Slurry shield
    - 6.3.6.3 Thixshield
    - 6.3.6.4 Hydrosshield
    - 6.3.6.5 Mixshield as a Hydrosshield version
    - 6.3.6.6 Hydrojetshield
    - 6.3.6.7 Hydraulic soil transport
    - 6.3.6.8 Soil separation in shield operation with hydraulic transport
  - 6.3.7 Face with earth pressure support
    - 6.3.7.1 Functional principle
    - 6.3.7.2 Scope of application and soil conditioning process
    - 6.3.7.3 Use of foam with earth pressure shields
  - 6.3.8 Blade tunnelling and blade shields

- 6.3.9 The most important verification calculations
- 6.3.9.1 Calculation of face stability with slurry and earth pressure support
- 6.3.9.2 Calculation of safety against breakup and blowout
- 6.3.9.3 Calculation of thrust force
- 6.3.9.4 Determination of the air demand for compressed air support
- 6.4 Tunnel boring machines in hard rock
  - 6.4.1 Categorisation of machines for use in hard rock
  - 6.4.2 Basic principles
  - 6.4.3 Boring system
  - 6.4.4 Thrust and bracing system
  - 6.4.5 Support system
  - 6.4.6 Ventilation
  - 6.4.7 The use of slurry and earth pressure shields in hard rock formations
- 6.5 Special processes: combinations of TBM drives with shotcrete tunnelling
  - 6.5.1 Areas of application
  - 6.5.2 Construction possibilities
  - 6.5.3 Example
- 6.6 Roadheaders (TSM) and tunnel excavators
  - 6.6.1 Basic principle of a roadheader
  - 6.6.2 Rock excavation by a roadheader
  - 6.6.3 Ventilation and dust control with a roadheader
  - 6.6.4 Profile and directional control of roadheaders
  - 6.6.5 Construction sequence using a roadheader
  - 6.6.6 Additional equipment and variations of roadheaders
  - 6.6.7 Criteria for the selection of a roadheader
  - 6.6.8 Comparison of partial face and full face machines
  - 6.6.9 Combination of full face and partial face machines
  - 6.6.10 Contour cutting process
  - 6.6.11 Tunnel excavators
- 6.7 Checking the tunnelling machine for suitability and acceptance based on a risk analysis
  - 6.7.1 Strategy to contain risk
  - 6.7.2 Basic design
  - 6.7.3 Analysis of obstructions
  - 6.7.4 Machine specification
  - 6.7.5 Acceptance of the TBM
  - 6.7.6 Shield handbook
  - 6.7.7 Data checks, functional tests
  - 6.7.8 Implementation of the strategy through the example of the Elbe Tunnel and the Lefortovo Tunnel
  - 6.7.9 Recommendations for the future