
Mechanized Tunnelling in Urban Areas



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Design methodology and construction control

Edited by

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Breakthrough of the Herrenknecht TBM at 'Sao Bento Station', under construction.
Porto Metro Line 'S' – Porto, Portugal.

Photograph by Piergiorgio Grasso, 2003.

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The entrance to the 'Sao Bento Station' of the Porto Metro, after completion.
Porto Metro Line 'S' – Porto, Portugal.

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Foreword

Fresh air to the conception of tunnels in urban areas

Sebastiano Pelizza

The world of underground engineering and construction has acquired a wide-ranging and high-level experience on tunnel construction with Tunnel Boring Machines (TBM), thanks to the remarkable increase in the number of tunnels that are becoming longer, going deeper, and growing larger in diameter. In other words, becoming more difficult to realize.

In urban areas, the acquired consciousness of preservation and care for the anthropogenic environment, accompanied by the improvement in the quality of life, has raised the level of difficulty and challenge in respecting the constraints deriving from human presence and, therefore, the necessity for a technological and intellectual approach to respond appropriately to these constraints.

This recent, invaluable experience gained from a series of accidents in urban tunnelling worldwide has made us aware that the TBM is simply not a fully mechanized tool integrating the various operations of the conventional excavation method for excavating more rapidly, and overcoming all (or almost all) the well-known problems and uncertainties. Instead, the TBM and the tunnel to be excavated, constitute a delicate and sensitive, unitary system, which should be managed with a new approach, rationally organized and scientifically sustained, in a unified context of research and design of the tunnel, the machine, and the environment.

In particular, all the principal risk factors are found to be associated with tunnels in densely populated urban areas, including the properties and services subject to risk, poor geotechnical conditions of the ground, presence of and consequent interference with water table, and the small overburden with respect to the excavation diameter.

The focus of this book is exactly on the problems of urban areas. Its authors want to analyze and propose not only the machines, but also, above all, the new special techniques for controlling the proper operation of machines and, consequently, the ground water drainage, the stability of the excavation face, and the resulting tunnel profile, for the purpose of minimizing the risks of subsidence. Therefore, a substantial portion of the book is dedicated to identify, evaluate, and manage such risks.

Framed in this particular manner, it seems to me that the book stands up above customary texts, in drawing attention to mechanized construction of tunnels in urban areas as a complex system that needs real or conceived certainties: adequate preliminary investigations for small depths must supply exhaustive information; scientific design that should not leave anything to be invented during construction; reliable and correctly equipped machines to face the foreseen potential emergencies; and planned construction managed by supervisors and technicians with demonstrable

qualifications. In this sense we try to supply at Politecnico di Torino a serious contribution of training with the commitment of a Master's Course of annual duration on "Tunnelling and Tunnel Boring Machines".

To sum up, I like this book for many evident reasons, of which I would like to highlight just a few:

- 1) It brings fresh air to the conception of tunnels in urban areas, placing in the forefront the fight against the risks, supplying in this way a reliable instrument for making rational and transparent choices to the decision-makers, who may be negatively shocked from the many cases of damage and collapse manifested in urban tunnelling history.
- 2) It is useful for the TBM users and operators who, in facing their duty to make the machine run at its maximum capacity, must acquire the consciousness that the consequent risks should be very well evaluated, anticipated, and minimized. The book is also useful for the students to whom we must try to impart the sense of "scientific humility" (auto-criticism is never enough!) and who must, as quickly as possible, learn the lessons from the available, collective experience.
- 3) Another important reason for my appreciation of this book emerges from the above two reasons: it is written by experienced technicians who clearly intend to show, through specific examples in which they were directly involved, what was the origin for the manifested risks, how they were approached and overcome, and how these risks could be avoided in the future.

How much more useful is it in our profession to re-analyze the critical situations, rather than taking glory for a piece of work that was well developed without obstacles!

Sebastiano Pelizza
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Past President (1995-1998) of International Tunnelling Association

Foreword

A creative application of the principle of Risk Management

Harvey W. Parker

Cities are not sustainable without infrastructure and, in many cases, the best choice for much of this infrastructure will be a tunnel. Accordingly, there is already, and will be in the future, a great demand for tunnels to be constructed in difficult and crowded urban settings. Not only are the constraints that these urban settings pose to tunnel construction quite challenging, but there are also extremely demanding performance requirements for minimal disturbance to the public and to the surrounding utilities, structures and the environment.

Fortunately, the authors have written this book which does an excellent job in describing the special approaches and requirements currently required when designing and constructing tunnels in urban areas. Very little about this important subject is currently available in our literature, except for short articles and conference papers which do not have the space to develop the subject in sufficient detail. This extensive and comprehensive book allows the authors to share their great combined experience and creativity at a level of detail not available elsewhere.

The data and methodology presented by the authors range from guidelines and practical rules of thumb to sophisticated computerized analyses. The authors have unselfishly shared their vast experiences and impressions of future trends in the fields of design, analysis, construction, and management. Thus, this book conveys wisdom of experience while still offering the promise and creativity of a rapidly advancing state-of-the-art.

The points made by the authors are backed up by references and case histories giving the reader practical, common sense examples.

One of the principal themes of the book is that creative application of the principles of Risk Management can, and should be, systematically applied throughout the planning, design, and construction of every project. The authors develop the concept of continuous, intense, and detailed evaluation of risks, which richly interconnects the various phases and tasks of a project together, in not only a realistic but also a practical manner.

The geotechnical uncertainties and the constructability, management, and health and safety issues, as well as risk avoidance and acceptance of residual risk are presented in a practical way based on common sense. Examples and guidelines are given rather than abstract ideas.

Although this book primarily addresses larger-diameter tunnels, the principles and methodology, especially those associated with systematic risk management, can

be applied to other tunnel and underground space construction that is required in the urban environment.

Again, the authors are commended for unselfishly sharing their experiences.

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