

# Geotechnik - Tunnelbau und Tunnelmechanik

## Tunnelling: Management by Design

Kolymbas, D.: Geotechnik - Tunnelbau und Tunnelmechanik, Springer-Verlag, Berlin, Heidelberg 1998, ISBN 3-540-62805-3, Price: DM 128.00  
Muir Wood, A.: Tunnelling: Management by design, E&FN SPON London and New York 2000, ISBN 0-419-23200- 1. Price: £ 40.00

Reviewing together two recently published engineering books on the same topic offers a welcome opportunity for comparisons. If such books are representative of the main currents of thought in their field, such a double review is especially appealing.

For decades there has been growing competition to conventional tunnelling from the so-called 'New Austrian Tunnelling Method' (NATM). The resulting split in the tunnelling community was recently aptly characterised by A. Haack, President of ITA: 'Some regard NATM as a cure-all drug and a philosophy, others regard it as a pseudo-scientific way of thinking' (Tunnel 7/97).

Muir Wood's book stands in the tradition of sound scientific methodology; that of Kolymbas is a fruit of the NATM ideology. The only thing the two works have in common is a length of around 300 pages. Muir Wood endeavours to communicate his rich experience, gained over a period of more than 40 years, to the profession, bringing in scientific aspects (among other things in the planning and execution of the Eurotunnel) where necessary. In doing this he can draw examples from numerous valuable publications. Kolymbas main aim on the other hand is, in his own words, to provide the missing 'theoretical foundation of NATM'. To fulfil this task - due to the pseudo-scientific nature of NATM - neither practical experience in tunnelling nor recourse to one's own research work is necessary. In fact, in his work Kolymbas does not refer to a single scientific contribution of his own or to any construction project in which he was personally involved. What this leads to will be illustrated by some examples. First, his approximate formulas, which are intended to 'explain the principles of NATM', are based on unrealistic assumptions only resulting in an inappropriate and unacceptable mathematical formalisation of tunnelling. It suffices here to mention his formula for determining the required lining resistance when using a system of grid anchors, in which he does not consider the influence of rock deformation. In this way he not only causes embarrassment to the proponents of NATM, but also contradicts himself, since in a previous chapter he recommends the method of the characteristic line, which takes into account the deformation of the rock to determine the lining resistance. The trough-shaped characteristic line proposed by Pacher represents

according to Müller 'the fundamental concept of NATM'. Kolymbas deals with it in great detail. This in a way is understandable, because the NATM literature lists numerous practical examples for the alleged use of the 'Pacher curve' to optimise the rock pressure (Tauern Tunnel, Arlberg Tunnel, Tarbela Project, Underground Power House Waldeck, etc.). In Kolymbas's opinion: 'in order to get by with as low a lining resistance as possible, the characteristic line of the lining should intersect at point B (minimum of the ground response curve) with the ground response curve. This NATM requirement is directed more to the intuition of the tunnelling engineer, from which - strictly speaking - the idea of the rising branch of the ground response curve comes, since the position of this minimum cannot be determined. The rising branch appears to be very plausible, but could not be verified up to now either by measurements or by numerical simulation.'

Kolymbas is perhaps unaware that with this statement he has made the protagonists of NATM (including Rabcewicz and Müller, who over a period of decades reported on concrete applications of the 'Pacher curve') guilty of scientific fraud. Since he cannot produce either an empirical or theoretical explanation for the basic concept and nevertheless claims it is reasonable, he relegates NATM to the realms of fantasy.

How far the author is removed from the realities of underground construction is shown in the following examples: 'Short anchors are relatively expensive, since the most expensive part is the anchor head. Thus a 24 m anchor only costs about twice that of a 3 m anchor'. He forgets the costs for drilling the borehole and inserting the anchor. The schematic representation of the method of action of slit-rod-and-wedge type of bolts (Fig. 10.3) or the explanation of the kerf cutting in the rock by the disc cutter (Fig. 11.1) is basically incorrect. Also we consider his newly created term 'tunnel mechanics' to be superfluous, for after all, applied mechanics has been associated with tunnelling for all of 200 years. We now turn to Muir Wood's book. The author's goal is to present tunnelling in a systematic way and he places his emphasis on the explanation of the processes, which during planning, design and execution always occur in a variety of ways, changing from project to project. Accordingly, he begins his work with an

explanation of the term 'system engineering' and points out the frequent differentiation in industry between 'product design' and 'process design' (i.e. providing the means of manufacturing the desired product). As a result he does not get bogged down in abstract management theory, but fills in the theoretical framework with expert knowledge, which is ordered and weighted according to practical criteria. Numerous examples of successful and less successful projects in many countries clarify the main points of his discussion. We know of no other textbook on tunnelling with a comparably large breadth of treatment, beginning with a brief historical introduction, among other topics he deals with the questions of preliminary planning, financing, contract procedures, site investigations, risks including their distribution, design, execution, geotechnical control measurements as well as project management. What impresses the reader most of all is the rich interplay between all these problem areas; in particular thematic interaction in the different phases of the realisation of projects involving underground construction is difficult to present in a generally valid way. Muir Wood has achieved this in an excellent manner, because he has not only directed many projects, but can also look back on an extremely active international professional life: Sir Alan Muir Wood, as is well known, was the first president of the international Tunnelling Association (ITA). A further special condition which has favourably influenced the coming into being of his work, he summarises as follows: 'The immediate spur to writing this book is that the author has lived and worked through a period of revolutionary change in tunnelling with several components.'

The concise presentation of the demanding topics presupposes that the reader possesses considerable basic knowledge and experience in tunnelling. The formulations are very pregnant, so that perhaps the reader - like the reviewer - has continually to write down sentences, which he does not want to forget. For professional colleagues on the Continent the sober British pragmatism, for which Muir Wood is an outstanding example, will definitely stand out positively. Thus he does not leave the reader with the false impression of a perfect world of tunnelling - on the contrary, e.g. when reappraising the events and analysing the damage following the collapse of the Heathrow Airport Tunnel in London. This chapter of his book, as every other, is prefaced by a quotation, which those who know the background details will find very apposite: 'The curious incident of the dog in the nighttime. The dog did nothing in the nighttime. That was the curious incident' (A. Conan Doyle).

Hardly any reviewed work is not thought to be in need of suggestions for improvement. Thus we think that the short section on analytical computational solutions as an aid to design and construction seems to be alien to the rest of the text in which the author helpfully describes the overall behaviour of the ground; this is particularly true for the stress state in the vicinity of a spherical opening. Thus in the next edition, chapter 8, devoted to the topic of 'Hazards, Disputes and Resolution', could be dealt with more explicitly. K. Kovári, Zurich/CH