BIBLIOGRAPHY ON SETTLEMENTS CAUSED BY TUNNELLING TO MARCH 1996

GEO REPORT No. 51

E.W. Brand

GEOTECHNICAL ENGINEERING OFFICE
CIVIL ENGINEERING DEPARTMENT
HONG KONG

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PREFACE

In keeping with our policy of releasing information of general technical interest, we make available some of our internal reports in a series of publications termed the GEO Report series. The reports in this series, of which this is one, are selected from a wide range of reports produced by the staff of the Office and our consultants. A charge is made to cover the cost of printing.

The Geotechnical Engineering Office also publishes guidance documents and presents the results of research work of general interest in GEO Publications. These publications and the GEO Reports may be obtained from the Government's Information Services Department. Information on how to purchase these publications is given on the last page of this report.

A.W. Malone
Principal Government Geotechnical Engineer
October 1996

FOREWORD TO THE SECOND EDITION

This is the second published edition of my Bibliography on Settlements Caused by Tunnelling, the first edition of which was published as GEO Report No. 10 in January 1992 and reprinted in 1995. The Bibliography contains the references of all directly relevant publications known to me as at March 1996. 'Publications' are defined as printed documents, of any size, which are accessible to the Civil Engineering Services Department; this includes published reports, theses and papers, as well as a few unpublished reports.

Items are listed alphabetically by authors' surnames, and the complete unabbreviated reference is given for each publication. The reference also indicates the existence of any published discussions on a paper, and the individually authored discussions are also listed as items in their own right separate from the paper. The date of publication is given after the author's name in each case, except that papers and other contributions to conferences are dated as having been published in the year in which the particular conference was held. The number of pages quoted for a publication signifies the total number of pages required to be photocopied to obtain a complete copy.

Where a publication has been abstracted by Geotechnical Abstracts, the GA reference number and publication date are shown in square brackets after the reference, e.g. [Geotechnical Abstracts, no. 149.64, 1978].

The symbols * and + which appear in front of some references have the following meanings :

* indicates publications which, in my view, are of major importance.

\+ indicates publications which contain Hong Kong data.

There are 758 references listed in this Bibliography, compared with 515 in the first edition. Twenty of these references are marked + as containing data on settlements caused by tunnelling in Hong Kong. The 38 publications designated * as being of major importance have been carefully selected as publications that summarize the state-of-the-art or which present unusually comprehensive collections of data.

The assistance provided with the first edition by Professor P.B. Attewell of the University of Durham and Professor E.J. Cording of the University of Illinois is acknowledged. My Secretary, Margaret Wong, has diligently maintained the Bibliography on a word processor.

(E.W. Brand)
Director of Civil Engineering
March 1996

BRIEF REVIEW OF THE LITERATURE

The 38 publications marked by an asterisk* in the Bibliography together give a complete picture of the state-of-the-art with respect to ground movements caused by tunnelling activities in a wide range of geological conditions. The majority of these items are review papers based on large quantities of previously published data, but a few represent thorough analyses of newly acquired data on large tunnelling projects or on a number of projects in similar ground conditions. They nearly all use data from and make reference to many other publications listed in this Bibliography.

Much good work has been done on the measurement and prediction of ground settlements by a team at the University of Durham, UK under the leadership of Professor P.B. Attewell, whose 1977 state-of-the-art review for tunnelling in soil (Attewell, 1977a) is excellent. In addition, the book by Attewell, Yeates & Selby (1986) is certainly the most comprehensive treatment of the whole subject area, and represents a considerable expansion of the earlier single chapter on tunnelling in soil by Attewell & Yeates (1984). These two publications adequately cover the majority of the subject matter dealt with in most of the previously published state-of-the-art reviews. The comprehensive review by Lake, Rankin & Hawley (1991) is also worthy of mention.

The earliest published attempt to predict ground settlements caused by soft ground tunnelling was that by Schmidt (1969), whose PhD thesis formed the basis of the well-known state-of-the-art report by Peck (1969). This work was later published in an expanded and updated form in a chapter of a book which also dealt with excavations in soft clay (Clough & Schmidt, 1981).

In the past decade or more, Japan has undoubtedly been the focal point of soft ground tunnelling, and a vast amount of data has been collected on ground movements by sophisticated measurements, which are now carried out routinely. The two excellent recent reviews of soft ground tunnelling by Fujita (1989, 1994) draw heavily on Japanese experience. A paper by Hanya (1977) gives details of 58 case histories of shield tunnelling in Japan, and another by Fujita (1982) statistically analyses over 100 sets of field data to produce predictions of the most probable settlements. It is worth noting that the published "Proceedings of the Second International Symposium on Field Measurements in Geomechanics", held in Kobe in April 1987, contain a wealth of Japanese data, and the recent review by Nomoto et al (1995) synthesizes recent Japanese experience. There are undoubtedly many publications in the Japanese language which are unknown outside the country.

In the United Kingdom, O'Reilly & New (1982) have published a summary of settlements caused by UK Tunnelling operations, and have suggested a semi-empirical method for predicting them. Hurrell (1984) has provided a further excellent review, but specifically for shield tunnels. The paper by Bell et al (1988) reviews not only settlements caused by tunnelling but ground movements caused by all mining and civil engineering activities. New & O'Reilly (1991) provided a more recent review of the occurrence and effects of tunnelling settlements.

Workers at the University of Illinois have for many years been concerned with tunnel

projects. Under the leadership of Professor E.J. Cording, they have produced a large number of published reports and papers documenting ground movements caused by tunnelling. In particular, they closely monitored the tunnelling operations for the Washington Metro, on which were based the state-of-the-art reviews by Cording & Hansmire (1975), O'Rourke, Cording & Boscardin (1977), Cording, O'Rourke & Boscardin (1978), Boscardin & Cording (1989) and Cording (1991). The last four papers are particularly valuable for the fact that they assess the likely damage to structures above tunnel works.

Other state-of-the-art reviews which are worth special mention are those by Reséndiz & Romo (1981b), Lo, Ng & Rowe (1984), Schlosser, Magnan & Holtz (1985), Fujita (1989, 1994), Negro & Eisenstein (1991), New & O'Reilly (1991) and Rowe & Lee (1992) for clays; Eisenstein & Negro (1985) for tropical and lateritic soils; and Kanji (1979) for rock. The general review by Uriel & Sagaseta (1989) on the selection of tunnelling design parameters is worthy of special mention.

Worth special mention as containing large numbers of good quality papers on settlements caused by tunnelling are the Proceedings of the International Symposium on Tunnelling in Soft and Water-bearing Grounds (Paris, November 1984), the International Conference on Soil-Structure Interactions (Paris, May 1987), the International Congress "Towards New Worlds in Tunnelling" (Acapulco, May 1992), and the International Symposium on Underground Construction on Soft Ground (New Delhi, January 1994). In particular, there are several papers which present valuable sets of field data on tunnelling under buildings in Paris, Tokyo and Seville in Spain.

Also worthy of special mention are the several papers on tunnelling written in Portuguese which were published in the Proceedings of the Fifth Brazilian Conference on Soil Mechanics, held in Sao Paulo in October 1974. These contain numerous records of settlements in Sao Paulo caused by tunnelling for Metro construction. The Brazilian Association for Soil Mechanics regularly holds conferences, and there are undoubtedly other papers published in Portuguese that contain information on tunnelling settlements.

In recent years, a great deal of tunnelling work has been undertaken in Cairo for the construction of a metro system and the implementation of the sewerage masterplan. Extensive monitoring of these works has produced some valuable ground movement data, much of which has been published in papers by El-Nahhas (1986, 1989, 1992) and El-Nahhas et al (1989, 1990, 1991, 1992).

The published papers by Morton & Dodds (1979), O'Reilly et al (1980), O'Rourke (1985), Wong & Kaiser (1987a, 1987b), Lee & Rowe (1991a), Clough & Leca (1993) and Forbes et al (1994) are notable for the comprehensive data that they contain on specific projects. The paper by Fang et al (1994) synthesizes published data from a number of projects.

Lastly, it should be noted that the 21 documents marked by a cross+ in the Bibliography contain data which was collected in Hong Kong, in every case but one (that by McFeat-Smith & Woods, 1990) during tunnelling operations for the MTR Island Line. Seven of these, however, are unpublished government documents, and they are therefore available only in the Geotechnical Information Unit of the Library of the Civil Engineering Services Department.

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