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The role of UK commercial organizations in the development of soil mechanics and foundation engineering, 1940-60

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SYNOPSIS

Although the part played by Government research institutions and universities in the development of soil mechanics and foundation engineering is well-known, little publicity has been given to the efforts of various UK commercial organizations in promoting the science and practice of the subject in this country and many countries overseas.

In the early years these organizations were mainly specialist departments or subsidiaries of major building and civil engineering contractors who regarded the work as enhancing their technical competence and prestige rather than as a money-making activity.

The Author was employed for nearly thirty years by the Central Laboratory of George Wimpey & Co, later becoming Wimpey Laboratories Ltd. In the early post-war years the laboratory was responsible for many innovations, including the introduction to UK and Middle Eastern countries of the standard penetration test. They also introduced the "sparker" system of marine geophysical surveying and its use in conjunction with geological and palaeontological studies in 1959 for the Channel Tunnel Project is described.

An account is given of the work in UK and overseas countries with particular reference to competition with other companies pioneering in the development of soil mechanics in the post-war period.

INTRODUCTION

The important part played by Government research institutions and the universities in the United Kingdom and the United States of America is well-known and has been the subject of many historical papers and memoirs in the ISSFME conference proceedings and elsewhere. However little publicity has been given to the role in the 1940-1960 period of a small number of British contracting organizations in promoting the application of soil mechanics and geology to practical design of foundations and earthworks around the world.

In the immediate post-war period (1945-1946) comprehensive facilities in the UK for drilling, soil sampling and laboratory testing were limited to only two or three commercial firms. Before 1939 soil investigations for civil engineering projects were usually undertaken by water-well drillers and mineral prospectors. The larger firms of consulting engineers would have had one or two engineers with practical knowledge of soil mechanics but none of these firms could provide a service covering the whole range of activity from drilling and soil sampling in the field to laboratory testing and the preparation of engineering reports. In fact the post-war establishment in the UK of contracting companies offering such comprehensive facilities was practically unique around the world. In mainland Europe this work was mainly undertaken by Government research institutions and the Universities. In USA the commercial exploitation of soil mechanics was promoted mainly by a few specialist firms of consulting engineers usually relying on contractors for the field work.

THE DEVELOPMENT OF COMMERCIAL SOIL MECHANICS LABORATORIES IN UK

In the inter-war years the development of soil mechanics in UK was almost wholly undertaken by two Government institutions, the Building Research Station and the Road Research Laboratory. Courses of instruction in soil mechanics were given by BRS from 1938 to 1945 for university lecturers, railway engineers, consultants and colonial service engineers, with the aim of wider dissemination of knowledge on the subject. University College, London, and the Universities of Sheffield, Durham and Glasgow gave lectures in soil mechanics in the 1938-45 period.

BRS had investigated a slip in the Chingford Reservoir embankment in 1937. The contractors for the reservoir construction were Mowlem, who consulted Professor Terzaghi on the stability problem. This led to the establishment by Mowlem of their own soils laboratory in 1939 with R Glossop in charge. During the war years this laboratory was concerned only with Mowlem's own activities, but in 1944 a subsidiary company of the contractor was set up and given the name of Soil Mechanics Limited to undertake soil investigations and geotechnical process as a service to the industry.

Among those attending the BRS lecture sources in 1939 was Dr William MacGregor of Glasgow University. In 1944 he was asked by Godfrey Mitchell (later Sir Godfrey) of George Wimpey & Co to join the company

Murdock from BRS was appointed as Manager. The Wimpey Central Laboratory, as it was then called, followed the lead of Soil Mechanics Limited in the commercial exploitation of the new science. This led to keen but friendly rivalry in the following years. The two companies and others which followed, including subsidiary companies of the Costain, Laing and Cementation companies, saw their activities as a means of enhancing the prestige and technical competence of their parent organizations. To further this aim the commercial laboratories undertook research into several practical aspects of geotechnical engineering. In some cases the research was undertaken in collaboration with academic and other scientific institutions and some significant developments were achieved. (Glossop et al, 1945, Meyerhof et al, 1953, Tomlinson 1957.)

The rivalry between SML and Wimpeys was intensified at the time of the 1957 ISSMFE Conference held in London. Both firms had exhibitions at the Conference headquarters and both opened their laboratories to technical visits by the international delegates. In a carefully planned move two of Wimpeys' senior engineers Stanley Rodin and Bruce Holt, "press-ganged" Professors Terzaghi and Peck into a waiting car and took them to the Wimpey Laboratories at Hayes, where Terzaghi characteristically seemed to be more interested in the display of geological specimens than the exhibits of equipment and case records.

FIELD TESTING OF SOILS

Nowadays it is not generally known that the standard penetration test was introduced to UK by Wimpey Laboratories in 1949. In 1948-49 we had undertaken an offshore soil investigation in Cyprus. The American consultants for the investigation had specified the use of the SPT. We bought the equipment from its manufacturers in USA and in due course it was brought back to UK. At this time Stanley Rodin, who had joined Wimpeys in 1944, had returned from a study course under Professor Peck in Illinois. The applications of the SPT were prominent in the course and Rodin returned home full of enthusiasm for the test, and foresaw its usefulness in UK soil conditions (Rodin, 1961). In the 1950s we introduced the test in Iran, Iraq and Kuwait.

SML can claim to be the first to use the field vane test commercially in UK. They used the equipment developed by the Swedish Geotechnical Institute for investigations in the deep alluvial silty clays of the Firth of Forth at Grangemouth (Skempton, 1948).

GEOPHYSICAL SURVEYING

Geophysical methods were rarely used in UK soil investigations in the 1940s and 1950s. Equipment for electrical resistivity surveying was available at this time but it was mainly used for water supply and mineral investigations. Some seismic surveying using explosive methods was used on dam sites (Robertshaw et al, 1955). In 1958 I visited Bechtel's New York office to discuss sea bed investigations for petroleum production platforms offshore of Iran. I was introduced there to Dr Charles Officer who had worked on the development of the continuous seismic profiler (the sparker) while at the Woods Hole Oceanographic Institute. I was impressed by Dr Officer's demonstration of the clear picture of the stratification below sea bed given by this equipment.

The Iran work did not proceed immediately but in 1958 Wimpey Laboratories were invited to submit a proposal for geological investigations across the Straits of Dover for a Channel Tunnel. At this time the feasibility of the tunnel was being studied by a joint Anglo-French-USA group. The chief French delegate to the group, M Rene Malcor, was sceptical about the feasibility of drilling below sea bed in unsheltered waters with the prevailing strong currents and few periods of calm weather. However Sir Harold Harding, a UK member of the group, had been a director of SML and he was well aware of Wimpey's experience in this field. We were pleased to have the opportunity to take M Malcor and Sir Harold to Dungeness at the southern end of the Straits where we were undertaking an offshore investigation in connection with a nuclear power plant.

In 1959 dynamically-positioned drillships and seabed-operated drills were not available and it was appreciated that deep boreholes on the planned tunnel alignment might not be practicable in the difficult environmental conditions. However a scheme was evolved by the Study Group whereby the outcrops and configuration of the rock strata, in particular the Lower Chalk through which the tunnel would be driven, could be established by a combination of seabed sampling, geophysical surveying and boreholes on the up-dip side of the tunnel route where the Lower Chalk was shallower. A geophysical survey by sonar equipment had been made in 1958 but the energy level was insufficient to provide information on the strata below a depth of about 30 to 40m from sea bed. After obtaining the drilling contract Wimpey offered the sparker method with equipment and operators from Alpine Geophysical Services brought over from the USA. This was successful and achieved penetrations between 50 and 60m and occasionally to 70m below the sea bed.

Confirmation of the depth and inclination of the principal Chalk beds was obtained by eight 25 to 69m deep boreholes across the Straits. An essential aid to this confirmation was the ability to identify the succession of the zones of microfossils in the Chalk established from deep boreholes on land and observations in the cliffs on both sides of the Straits. By correlating the established microfaunal succession with chalk samples recovered from the sea bed and the offshore boreholes the outcrop and configuration of the Lower Chalk was projected and preliminary vertical and horizontal alignment of the tunnel could be determined (Bruckshaw et al, 1961).

This combination of mapping of surface exposures, geophysics, palaeontology and sub-surface drilling was probably unique in the history of undersea engineering projects.

In collaboration with Alpine Geophysical Services, Wimpey Laboratories carried out many more geophysical surveys with the sparker equipment for civil engineering projects, including electric power cable tunnels below the Thames and Severn estuaries, the Storeabelt tunnel in Denmark, and cross-harbour tunnels in Hong Kong and Auckland.

GEOTECHNICAL PROCESSES

Within the period of this review Wimpey Laboratories could not overtake the long lead in the techniques of grout injection developed by SML and the Cementation Company who had been undertaking these activities in the inter-war years, but innovative techniques were developed for filling abandoned coal mine workings with low density foamed concrete (Scott, 1957).

In the 1950s the Laboratory developed and patented a wellpoint filter used on a large-scale for de-watering the excavation for the Pakistan Navy drydock in Karachi.

Also, with the advice of Dr Leo Casagrande who was working at BRS at the time, we introduced electro-osmosis to UK in 1949. The method was intended to stiffen the very soft clayey silts and hence arrest the sinking of large multi-cell caissons for the buoyant foundations for the Grangemouth Refinery power station in Scotland (Pike et al, 1952). The current flow from the anodes to the cathode wells produced very little water discharge from the wells and although the caisson sinking was arrested we never knew whether this was due to the effects of electro-osmosis or to the regain of soil strength during the cessation of grabbing activity from the cells in the waiting period while the electro-osmosis system was installed.

OVERSEAS ACTIVITIES

Soil investigations in overseas countries were a major part of the Wimpey Laboratories work in the 1947-1960 period. They were mainly undertaken in the Middle East and Far East in connection with building and civil engineering contracts obtained by the parent company. In 1949 Wimpeys were awarded the contract to build the new Bank of China in Hong Kong. It was sited adjacent to the 1930s Hong Kong and Shanghai Bank. The rivalry between the two Banks was such that the new 17-storey building was designed to overtop its neighbour and would, for a few years, be the tallest building in the Colony (Tomlinson et al, 1953).

I arrived on site early in 1949 after the then six-day BOAC flying boat journey to find that the only available drilling equipment was a Chinese hand-operated rig designed for sinking shallow water wells. Nothing was known about the likely depth and geotechnical properties of the clayey decomposed granite found below a few metres of rubble and boulder fill covering the original foreshore. It seemed to be essential to obtain some undisturbed samples for laboratory testing so I sketched from memory the details of the BRS design of the U(100) sample tube, cutting shoe and sliding hammer. After only a few days a set of sample tubes and all the other gear was made in a local garage and delivered to site. Final proving of the depth to fresh granite had to wait for the arrival of a rotary core drill sent by air freight from UK.

This work was followed four years later by a very large investigation for the Kai Tak airport runway on the reclaimed harbour bed extending from the Hong Kong mainland. The work included 400 marine borings and 50 trial pits (Grace et al, 1957). The Wimpey site representative was Peter Lumb, who remained in Hong Kong and later became Professor of Civil Engineering at the University.

A branch laboratory was opened in Baghdad in 1951 and operated for nearly ten years until the period of civil unrest following the overthrow of the Hashemite dynasty made it impossible to continue. Wimpey staff could tell hair-raising stories of the events during the Revolution. Investigations in Iraq for the Baghdad International Airport, the Baghdad-Basra Highway and low-cost housing schemes included studies of seasonal temperature and moisture gradient in covered and uncovered soil surfaces (Hatherley et al, 1957), (Hatherley, 1961).

The first sea bed investigations for offshore petroleum production platforms involving drilling in deep water were made off the coastal areas of Abu Dhabi and south-west Iran in the 1955-62 period.

Soil Mechanics Ltd can claim to be the first to introduce rock coring for engineering purposes and testing of rock specimens at Singapore in 1951 in connection with foundation problems for a multi-storey building (Nowson, 1954).

The opportunities for UK soil investigation companies described in this article no longer exist. Nowadays local facilities for soil investigations are available in almost every country in the world and many government research institutions have been established to study geotechnical problems particular to their regions. The Author is glad to have had this opportunity of putting on record the pioneering work of UK commercial organizations in the 1940-60 period.

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