

DEVELOPMENT OF THE GEOTECHNICS ON THE TECHNICAL UNIVERSITY

Prof. G. PETRASOVITS

Department of Geotechnique
Technical University, H-1521, Budapest

Received May 9, 1990

Looking back

This is the first occasion since October 20., 1983., the death of Professor Dr. Árpád Kézdi, member of the Hungarian Academy of Sciences, former head of our Geotechnical Department, that the teachers and researchers of the Department publish their papers in a separate volume. This is why we want to take the opportunity to recall with reverence the memory of Professor Kézdi, the internationally reputed scientist of our profession, and to dedicate this volume to his memory as a sincere evidence of our respect. The spirit of his activity is still alive, we use the results of his work day after day. We use his results with deep respect as he did the same with the scientific achievements of his predecessors.

It is a honouring task also for us to recall the memory of those former Hungarian professors who started, developed and raised our field to an international appreciation.

The aim of this looking back is not a review or evaluation of the predecessors' work. The aim is to remember and to remind those scientists who actively contributed to the development of our profession in this country.

The subjects belonging to our Department developed in relationship with the beginning of railway construction around the middle of last century. An excellent representative of railway construction and transportation matters was the ordinary university professor Sándor Lippay (first corresponding member of HAS and ordinary member in 1896), whose 3 volume-book "Railway Construction" was edited in 1885.

Later, between the turn of the century and 1920 the three base subjects of our Department — namely: Earthworks, Foundation Engineering and Tunnelling — belonged to the "*Department of Road- and Railroad Construction*", that has been headed since 1906 by professor Szilárd Zielinsky. He was the first person awarded with the title of "Doctor of Technical Sciences" in Hungary. Later, in consequence of the industrial development, this Department parted and the head of the new one since 1918 has been the professor Kornél Zelovich. He became corresponding member of the Hungarian Academy

in 1921 and ordinary Member in 1928. The new Department got the name of *Transportation Matter and Railway Construction* succeeded to the teaching of our subjects. This period between 1920 and 1941 can be considered as the period of birth and forming of Soil Mechanics as an independent field of science. During the same time the Soil Mechanics became an indispensable practical tool for the designer and constructor civil engineers. In the development of this new scientific field a pioneer role can be attributed to professor József Jáky. He — among the firsts in Europe — organized a Soil Mechanical Laboratory in 1928, at the Technical University shortly after he returned from a one year study tour in USA. He spent the year of 1927 at MIT Cambridge beside professor Terzaghi.

Thank to his activity, the Earth-Statics and Soil Physics gained increasingly higher importance in education. József Jáky was promoted in 1936 to extraordinary professor and in 1939 to ordinary university professor. He became corresponding member of HAS in 1942 and ordinary member in 1949. In consequence of his work, the main point in the teaching profile of the Department got modified significantly and this was followed with change in the name also: between 1942 and 1950 the Department functioned as "*Department of Railway Construction and Earthworks*".

In this period, beside the Railway Construction, Soil Mechanics, Foundation Engineering and finally the Tunnelling became independent subjects.

Professor Jáky was a really creator type, outstanding scientist and his results in many topics, especially in the field of earth-pressure theory, and

behaviour of pile under load are even now in use all over the world.

On 13th of September, 1950 he suddenly died and his highly creative activity stopped.

In the year 1948 Professor Károly Széchy, correspondent member since 1949 ordinary member in 1973 of HAS became the lecturer in subject of Foundation Engineering.

Later, in 1951 he also began with teaching Tunnelling as an independent subject.

Professors Széchy and Jáky had determinant role in the reconstruction period after the 2nd World War, e.g. in the reconstruction of the bridges over the rivers Danube and Tisza.

They prepared also the soil mechanical reports for the Budapest Metro construction and were involved in the design and supervision of this great construction work.

The big construction works in the country, the direct and indirect participation in the design and construction of the Budapest Metro, all got role in the forming of the professional fields of the Department.

In 1951 two departments were created from the former one: Railway Construction Department and *Department of Tunelling, Earthworks and Soil Mechanics*. In 1964, without any change in the fields of activity, the later one got the name "*Geotechnical Department*", the name that became more and more widely used in the international scientific life in our profession.

In 1951, after a Prof. Jáky's death, Árpád Kézdi succeeded to the heading of the Department and continued with great impulse Prof. Jáky's work. He was promoted to professor in 1961. He became corresponding member of the Hungarian Academy in 1970, ordinary member in 1976.

He was the Head of the Department for more than 30 years, the international acknowledgement of the soil physical and earth pressure theory investigation results should be attributed to his scientific activity.

The activity of Árpád Kézdi in Soil Mechanics and Earthworks, as well as of Károly Széchy in the field of Foundation Engineering and Tunnelling yealded in enduring results. Professor Széchy's book "*Art of Tunnelling*" — about 900 pages — is used in all of the more important countries as a reference book similarly to his two-volume book "*Foundation Engineering*".

From the 1950-s the dominant part of the research topics of the Department involved the fields of soil physics, earth pressures and soil load bearing. The primary condition of geotechnical investigations is a proper laboratory background. Significant improvement in the equipment of the laboratory founded by Prof. Jáky came about in 1974, when the new Construction Laboratory of the University was completed. Investigation conditions of the Geotechnical Department were suddenly and significantly improved by the numerous up-to-date equipments. In the shaping of new research policy of the Department the Author also got a role. By the 1970-s, further development in soil mechanical and foundation research by classical methods were impossible, no new results were to be expected from the investigation of these topics with conventional methods.

Research on the Department between 1983 and 1986 International cooperation.

A primary condition of high standard university education is fitting the new, practically applicable investigation results into the subject-matter of instruction, thus helping directly or indirectly the bringing of new design or construction possibilities in the civil engineering practice. This activity requires not only following with attention the new results in the Hungarian and international practice, but supplementing and developing them with own researches in the more important fields. This is the way on which the modernizing of subject-matters becomes a continuous work. The results of research enrich the education and the education reacts favourably upon the research.

The professional international connections of the Department gained a new impulse in this period and numerous internationally reputed scientists visited us. Our scientific results were greatly respected, therefore several young scientists were sent to us for professional visits. In this way our scientific results became lasting and continuous basis of professional cooperation.

The most important conditions of the successful research are the selection of topics and choosing the most suitable way of performance beside the given personal and material basis. The choice of research topics, giving new and practically applicable results, has determinant role both in solving our professional problems and in keeping pace with the pressing international results. In addition to follow with attention international tendencies, methods and results, we achieved results in some fields, drawing international attention, thus contributing to the further development of our international relations.

In 1984 the *6th Budapest Conference on Soil Mechanics and Foundation Engineering* gave another impulse to our international relations. More than 80 papers were submitted to this Conference from 17 countries of the world and the representatives of the more important countries in our profession participated it including numerous outstanding personalities.

(Mention must be made, that the first conference was organized by a Károly Széchy in 1955 in memory of Prof. József Jáky. The following 4 conferences were organized by Prof. Kézdi, thereby becoming the Budapest Conference an internationally respected forum of our profession.)

The Conference gave such opportunity for presenting our scientific activity and results, on the basis of which more and more leading representatives of our profession received invitation into working committees, to give lectures at universities, to perform offices.

A wide-ranging cooperation developed in the field of piling and the behaviour of ground anchors under load with the State University of Gent in Belgium, the University of Göteborg in Sweden, the Bradford University of Great Britain, just mentioning the more important ones.

Close relations have developed also with the Department of Geotechnique and Foundation Engineering of the Building Construction University of Moscow and regular research cooperation came into being with the Geomechanical Research Institute of the Bulgarian Academy of Sciences.

In the stabilization of the international research relations, beside the proper selection of the topics, the introduction of highly instrumented laboratory and site investigations and the computers in some fields simultaneously with the international forefront, had also a great role.

These conditions highly contributed to the complex investigation of some topics and yielded such new scientific results that were practically applicable, new calculation models could be developed resulting in remarkable economical savings in more fields.

A part of these scientific achievements utilized the lasting results bequeathed to us by Professors Kézdi and Széchy.

Our own most important achievements of this period are as follows:

Field of Foundations

— to widen the application field of *shallow foundations*, a critical analysis of known soil models was performed. In this way we examined Repnikow's model and developed a calculation method that took three-dimensional stress conditions into account. This method proved the applicability of shallow foundations among different ground slope and loading conditions.

Making use of this calculation method, shallow footings were designed and built under such soil conditions, where only deep foundations had been used previously. This meant more than 100 million forints savings in 1982—83 for the society.

The method developed under the guidance of the Author, was summarized in a Technical Code according to the command of the Minister of Construction and Urban Development. Later, making use of our method and prefabricated footings patented by us, a 10 level apartment building was constructed in Szeged.

In the field of *excavation supports* a wide range of experimental and theoretical works have been done in connection with anchored diaphragm walls and sheet-pile walls. Based on full-scale, in-situ instrumented, grouted anchor test results, a calculation method for anchor load bearing capacity has been worked out. Also in-situ tests were made on the stresses and strains inside reinforced concrete diaphragm walls with the help of pressure cells and strain gages. The displacements were measured and the real earth pressures were calculated. These results were checked with the method based on the elastically bedded beam developed also by the Department. Both the anchor load bearing calculation method and the elastically bedded beam method for calculation of diaphragm and sheet pile walls were applied numerous times in the practice.

There are traditions at the Department for investigating *piling problems*. Such problems were dealt with also by Professors Jáky, Széchy and Kézdi.

For a long period of time Author himself made tests on instrumented small-scale and full-scale piles, both laboratory and in-situ, to determine load bearing and load transfer mechanism of single piles and pile groups. During the tests, load bearing and settlement data of single piles and pile groups were checked with the help of a finite elements program developed by us, taking linearly and nonlinearly elastic conditions into account.

Instrumented reference pile was made and patented to investigate real soil stress conditions. The pile made under the guidance of the Author, has a diameter of 138 mm, and is suitable for measurement up to 12 m depth.

During the measurement the lateral stresses and the pile force can be measured by 1.5 metres separately and also the pore water pressure at the pile point is measurable. Later from the measured data the load bearing of any diameter driven piles can be predicted well in advance and the conventional test loading might be left out.

Field of Tunnelling

— To discover the causes of *surface subsidences* during the construction of the two new lines of Budapest METRO, processing of enormous amount of data together with theoretical investigations were done that resulted in a calculation method for the prediction of the probable subsidences during the construction. The method gives the width of subsiding area, the maximum subsidence and its development in time for both the lines and the stations.

For the calculation of *tunnel lining* such finite element method was worked out.

Prof. Dr. Géza PETRASOVITS H-1521, Budapest