

# INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING



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GENERAL REPORT ON THE ACTIVITIES OF THE SECOND INTERNATIONAL CONFERENCE  
ON SOIL MECHANICS AND FOUNDATION ENGINEERING, ROTTERDAM JUNE 21 TO 30, 1948

This general report is written for the information of those interested in the origin, the purpose, the preparatory organization and the activities of the Conference. So it will serve as a permanent record of the most important events, meetings and excursions, which have taken place, and of the experience gathered in organizing this important event. It can not give the real value of the Conference as it is impossible to give a record of a great many interesting happenings and of the intimate personal contacts between the participants, which will remain pleasant memories and will help for a better collaboration in the future.

It is hoped that this report further will be of value for the organizers of the next Congress.

PURPOSE OF THE CONFERENCE.

The overwhelming number of contributions and the quality of the reports received on the First International Conference in Cambridge Mass., gave rise to the desire that the valuable work of the Conference and a cooperation of its members should be continued. A proposal regarding the continuation of the work of the Conference was presented by Mr. Carlton S. Proctor, who suggested to hold this Second International Conference in Holland, because of the work done there and because of its central location.

In a resolution adopted by the Conference was expressed that this second Conference be called to meet at a time and place to be selected by the President, with the advice of the International Committee. Preparations for this Second International Conference in the Netherlands in 1940 in honour of the opening of the Maastunnel at Rotterdam, were taken in hand, but alas were soon interrupted in consequence of the second world war, which prevented the organization.

Soon after the war, the time came to resume the former plans. As the war had interrupted the needful international relations and because all sorts of troubles prevented personal contact and the obtaining of new literature it was certainly the moment to get the scientific workers on Soil Mechanics together and to give more publicity to the results of their work. For this reason the purpose of the Second Conference could be summarized as follows:

1. to renew the international contact of the specialists in Soil Mechanics;
2. to collect the most recent information of the various new or extended laboratories, especially of their works program and specialities;
3. to improve international cooperation;
4. to collect and compare the results of various investigations which have been made in different laboratories and those which are still in progress and the closer collaboration of the specialists in order to advance the science as rationally as possible;
5. to collect as much information as possible about the development of Soil Mechanics and its applications and to place

this information at the disposal of all interested engineers.

After preliminary discussions with the President, an Organizing Committee was formed. The Netherlands Government and the Municipality of Rotterdam invited the Permanent Committee of the International Conference on Soil Mechanics and Foundation Engineering to hold the Second Conference in 1948 in Rotterdam. Although the Netherlands were no more the prosperous country as before the last war - on the contrary they came out of this war as one of the most heavily damaged and pillaged countries - the Government and the Dutch people wished to show how much energy and resources were already directed to overcome the endured evils of the war. It was symbolic, that Rotterdam, the most heavily damaged and pillaged countries - the Government and the Dutch people wished to show how much energy and resources were already directed to overcome the endured evils of the war. It was symbolic, that Rotterdam, the most heavily damaged large town of the country, has been chosen as the set of the Conference. During and after the Conference there was plenty of opportunity to take note of the measures which are being taken everywhere in the country to restore the damage in the sphere of Public Works, Industrie and Housing.

The attraction of the Conference was increased as the Second World Conference for the Technical Science of the Underground Town Planning has been held at the same time. The main point discussed at this Conference was the planning and exploitation of underground Constructions.

ORGANIZATION OF THE CONFERENCE

The Organizing Committee was honoured by the information, that the Conference would be under the high patronage of Her Majesty the Queen of the Netherlands. Different dignitaries from the Government, the Delft Technical University, Municipalities and Directions formed a Committee of Honour. Professor K. Terzaghi, who was elected in 1936 as President of the International Conference acted in that capacity during this Second Conference. Professor A.W. Skempton was asked to act as Vice President and Ir. T.K. Huizinga acted as Secretary to the Conference. The Organizing Committee soon appointed subcommittees on registration, information and hotel accomodation, on excursions and transport, on meetings, for the editorial work and for the ladies. In total about 50 persons have done their utmost to make the Conference a success. During the registration day about 30 extra persons were in charge in order to facilitate the work to be done in the few hours available.

PARTICIPATION

The Organizing Committee issued preliminary bulletins in May and September 1947 in which the Conference was announced, particulars were given of a tentative program for the meetings and the subjects to be treated and in which the conditions for the contribution of reports were

stated. Bulletins of January and April 1948 contained application forms and further particulars for participants of the Conference.

Anyone interested in the Conference whether from the standpoint of practical application, research or teaching, was welcome to attend the meetings and to contribute reports or discussions. To compensate a part of the routine expenses of the Conference a sum of 20 guilders was required from the participants. It was difficult to estimate the number of participants. Taking into account, that the first Conference had about 200 members, that the science of Soil Mechanics has grown very much during the last decade, but also the difficulties which still existed on money exchange and traffic between different countries, plans were made for about 300 participants. This tax actually was far too low and the overwhelming number of 596 participants has given some trouble, for example for hotel accommodation as several hotels have been destroyed during the war, both in Rotterdam and The Hague.

A complete list of participants arranged according to their countries is contained in this volume.

#### LANGUAGE

Just as in 1936 the Organizing Committee carefully considered the question of language barriers and decided in concert with the Pre-

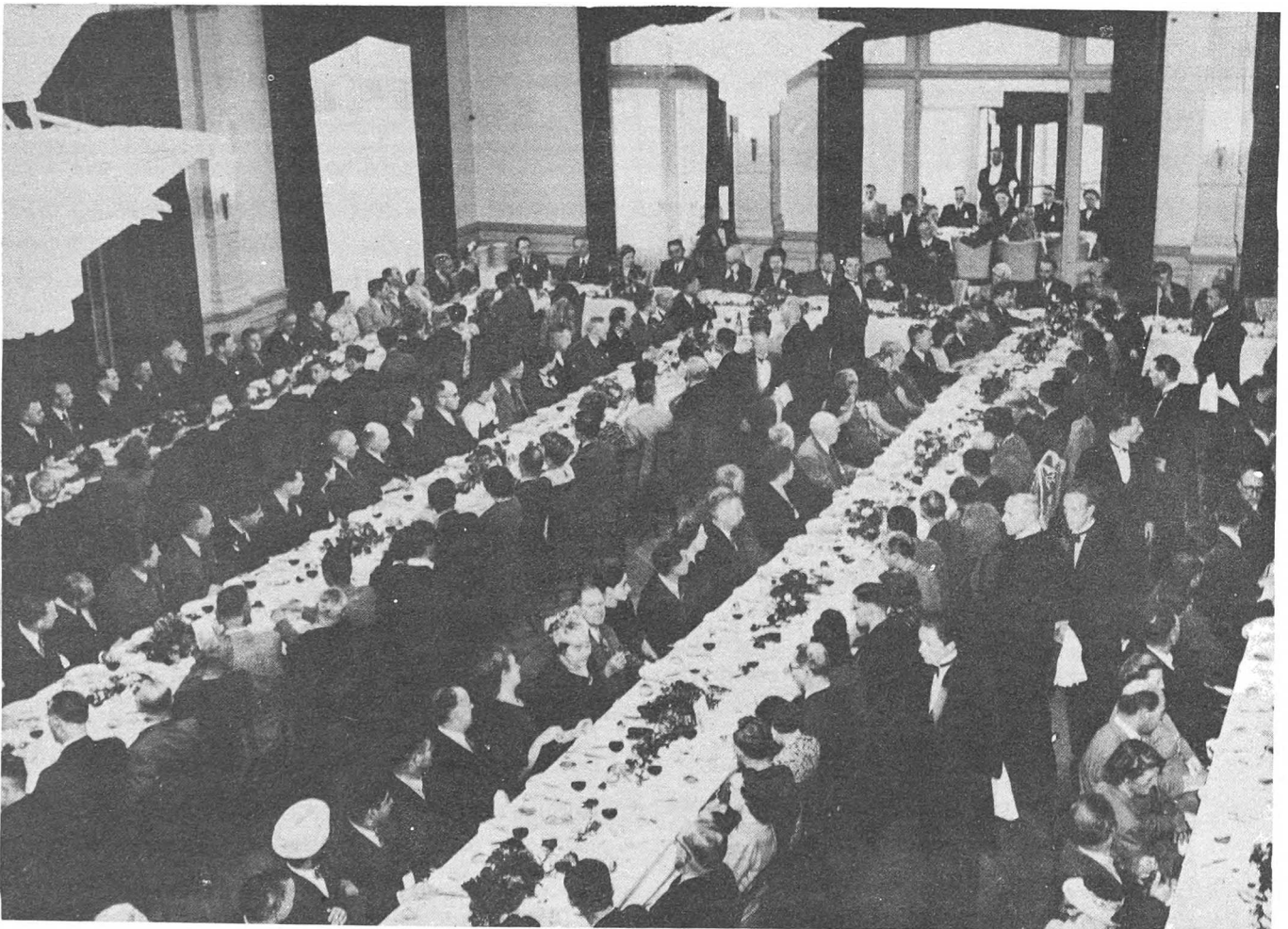
sident of the Conference to confine the Proceedings of the Conference essentially to the English language. The favourable result obtained in Cambridge has promoted this decision. It was expected that the use of one official language would contribute much to the success of the Conference, while by that means the cost of the Proceedings would be less. As it was expected that this requirement would be a hardship for some members, interpreters were present at the Conference to help those members who did not speak English fluently.

The use of a single language made it possible to have printed five volumes of the Proceedings prior to the Conference.

#### CONTRIBUTIONS

In accordance with the purpose of the Conference there were no restrictions as to the number of contributions placed, provided they were within the scope of the Conference. However, to make it financially possible that all papers could be included in the Proceedings and that, in order to stimulate discussions, these papers would be available in printed form prior to the Conference, certain restrictions in regard to the length of the papers had to be adopted and the submission should be not later than first January 1948.

The following abstract from bulletin No. 2 covers this subject in detail.



Informal dinner at Kurhaus Hotel, Scheveningen.

# CONDITIONS FOR THE CONTRIBUTION OF REPORTS

In accordance with the purpose of the Conference there are no restrictions as to the number of contributions, which may be accepted, provided they are within the scope of the Conference and as far as the contents are still not published in one or other magazine before first January 1948.

In this way it is hoped to make available as much new information as possible about the advances in Soil Mechanics and their applications to the world of engineers.

The contributors must hold themselves to the undermentioned instructions if the intended purpose of the Conference is to be fully accomplished:

1. a definition of the subject in the English language of maximum 500 words must be submitted in triplicate to the Secretary not later than 1st October 1947. This will be taken as a notification of intention to submit a paper, and all further necessary information regarding the contribution will then be mailed to the author,
2. each contributor shall submit to the Secretary not later than 1st January 1948, five copies of his papers in English of not more than 2500 words. The papers should contain a well considered summary, conclusion and all necessary figures and tables. It is very essential that titles and nota-

tions and numbers in the figures should be clear and of such dimensions that a clear photographic reduction of the figures will be possible. All photographs should be glossy printed and at least 4 inches wide, papers which may be eventually published after 1st January 1948 may also be submitted. If the publication is not in English the contributor must keep to the conditions outlined under 2. If the publication is in English, it will suffice that the contributor furnishes 300 reprints of his paper to the Secretary, instead of the conditions under 2, if this should be before 1st May 1948. These reprints will be mailed to the members of the Conference together with the reports mentioned under 2.

There are no restrictions on the publication of a paper after it has been submitted to the Conference.

In this way it is hoped to distribute the papers in sufficient time before the Conference, so that everybody will be able to study them and, if possible, send written observations and discussions to the Conference.

When the Conference is over, these observations together with the transactions of the Conference will be placed at the disposal of members in a supplementary volume.

As literature since the war is difficult



A serious problem

to obtain it is recommended that a national exposition of the latest developments and ideas in the sphere of Soil Mechanics with a list of literature, should be given.

It is planned to publish the reports sent to the Conference. Whether it will be possible to publish all papers in full cannot yet be stated. If there are any restrictions with regard to the publication, the merit of the contributions will be determined with the help of a questionnaire, which will be submitted to the authors.

Discussions will be published following the Conference unless it is requested otherwise.

#### SUGGESTIONS TO THE CONTRIBUTORS

It is very desirable that the following suggestions will be carefully considered by the contributors. All papers or discussions dealing with the behaviour of a special type of soil shall contain a reliable description of it, while at the same time the stated behaviour should be explained with sufficient test results to enable the reader to compare these results with his own experience. Excellent papers may lose their entire value by using vague names without adding data fixed by test results.

Particularly the results of field tests are very important for the Conference, such as: settlements records over long periods, accurate pile loading tests, etc.

It is necessary that all results of special tests in Soil Mechanics Laboratories shall be widely known. Therefore the directors of these laboratories are requested to submit to the Conference reports on such tests. The author is requested to omit details of limited interest and to replace descriptions which can be given more simply by graphical representations and tables by such.

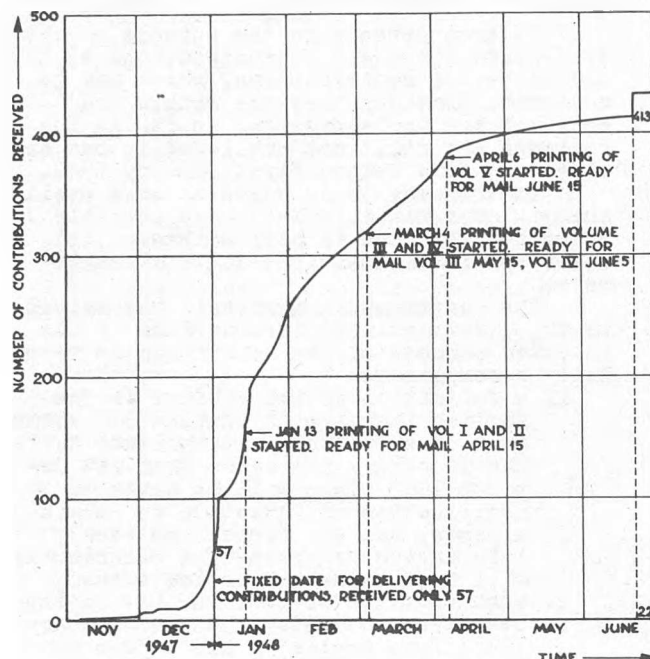
It is urged that contributors replace the written word as much as possible by drawings, diagrams, photographs and tables. By this, the text should be clear and brief (maximum 2500 words). A varied subject can better be presented in two short articles than in one long article. A short introduction should precede the article in which the purpose is explained and it should be concluded by a short summary. The lettering on all illustrations should be clear and large enough to permit reproduction on a considerably smaller scale as is usual in technical magazines. Particular attention should be paid to this detail. Generally speaking drawings made for other purpose are not suitable for good reproduction. All photographs should be glossy prints and their smallest dimension should not be less than four inches (10 cm).

Of the entire number of 413 contributions which were accepted prior to the Conference only 57 were submitted on the fixed data. In the 6 volumes of the Proceedings 392 will be printed.

Efforts are now made to print the remaining contributions and those received in the French language in a 7th volume.

To give an idea about the difficulties the editorial board and especially the printer have had to print the reports in time, a diagram is given in which the number of contributions received is plotted against time.

For this Second Conference the number of contributions proved to be far more as initially was expected. This fact and be-



cause they were handed in at a very late date made it not possible to have them printed in the sequence given in the program of topics. On the contrary contributions belongin to one section had to be placed in different volumes of the Proceedings.

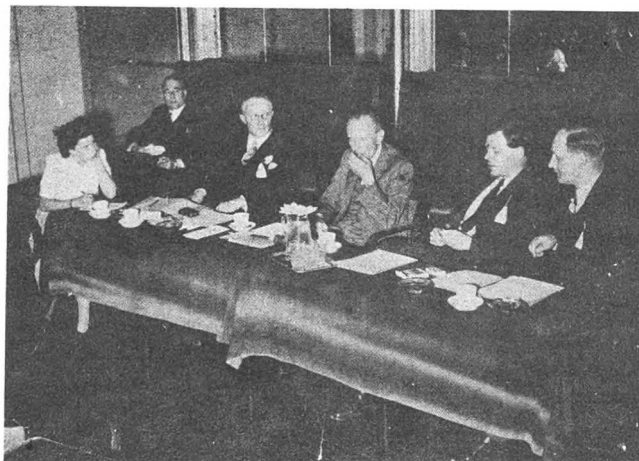
#### MEETINGS AND OTHER EVENTS OF THE CONFERENCE

##### Monday June 21.

For the members arriving in Holland, information offices were provided in the Conference building "Palace Theater", Rotterdam, and in the lobby of Hotel Kurhaus, Scheveningen.

At 5.30 P.M. the Royal Netherlands Institution of Civil Engineers had invited the President Prof. K. Terzaghi and the Vice President Prof. A.W. Skempton with the Organizing Committee and their ladies for an aperitif in their office.

At 7.00 P.M. this company drove to Scheveningen where about 400 participants already were assembled for an informal dinner in Hotel



Special meeting on international collaboration.



Kurhaus. The Royal Netherlands Institution of Engineers was represented by their President Dr. Ir. J.A. Ringers, who presided the table and cordially welcomed the participants and the ladies. This dinner intended to enable members to make acquaintance and to see old friends, was a success so that after dinner most of the members stayed until late in different bars in the neighbourhood.

#### Tuesday June 22.

In the forenoon the registration of the members at the Palace Theater took place. More than 65 persons registered of whom no prior announcement had been received, thus taxing the lodging accommodations to the utmost.

At 2.00 P.M. the opening of both Conferences in the City Theater of Rotterdam took place. An opening word was spoken by the President of the Organizing Committee Ir. J.P. van Bruggen, Chief Director of Public Works, of Rotterdam after which the opening address was submitted by Dr. Ir. W.J.H. Harmsen, General Director of the Rijkswaterstaat, representative of the Netherlands Government. Prof. K. Terzaghi gave in his presidential address a short resume of the progress in the science of Soil Mechanics after the first Conference. Ir. J.P. van Bruggen after acknowledging the addresses then closed the meeting.

In the evening half of the members assembled for a visit to the Laboratory of Soil Mechanics at Delft, where they were welcomed by Ir. E.C.W.A. Geuze, Head of Research Department of this Institute.

In Palace Theater a meeting of about 20 representatives of different national committees took place to discuss the statutes of the International Society for Soil Mechanics and Foundation Engineering, Prof. Terzaghi presided this lively meeting, which lasted until very late and resulted in a proposal to the Conference.

From 17.30 - 19.30 the American members of the Conference were invited by the American Consulate in Rotterdam for a cocktail party.

The ladies made in the evening an excursion to the old town of Delft, where remarkable, buildings, the canals and a shop of Delft pottery were visited.

#### Wednesday June 23.

9.30 - 12.00 First meeting. J.D. Justin presiding.

9.30 - 10.00 Lecture by Prof. Ir. P.Ph. Jansen on the closing of the gaps in the dikes of Walcheren.

10.00 - 12.00 Opening discussions by the reporter Prof. A.E. Bretting on the sections IV, V and X on earth constructions, earth pressure and ground water. Discussions with closing remarks of Prof. Terzaghi.

14.00 - 16.30 Second meeting. R. Glossop presiding.

14.00 - 14.30 Lecture by Ir. D.H. de Herder on the harbour reconstruction at Rotterdam.

14.30 - 16.30 Opening discussions by the reporters Prof. A. Caquot and J. Lehuérou - Kerisel on the sections VI and VII on raft and pile foundations. Discussions with closing remarks of Prof. Terzaghi.

20.00 - 22.00 A second group of members visited the Laboratory of Soil Mechanics at Delft, where they were welcomed by Ir. T.K. Huizinga. The ladies made an excursion to Amsterdam, where they visited the State Art Museum.

#### Thursday June 24.

9.30 - 12.00 Third meeting. Prof. K. Terzaghi presiding.

9.30 - 10.15 Lecture by Ir. J.L.A. Cuperus on the stabilization of railway embankments, with motion pictures.

10.15 - 12.00 Opening discussion by the reporter Dr. Ir. E. de Beer on the organization of the International Conference. Discussions and fixing of the statutes.

By lack of time the discussions on international collaboration were not held.

14.00 - 16.30 Fourth meeting. Fr. A. Marston presiding.

14.00 - 14.30 Lecture by Ir. J.P. van Bruggen on the construction of the Maas-tunnel at Rotterdam.

14.30 - 16.30 Opening discussion of the reporter W. Kjellman on the sections II and III on investigations in the laboratory and the field. Discussions.

The ladies made a trip to Haarlem along the dunes to visit the Frans Hals Museum.



Dinner in Rotterdam Townhall.



Cherry - time.



Rostrum during discussion.



Boat trip through Amsterdam.

17.00 - 23.00 Official reception by the Municipality of Rotterdam with an aperitif and banquet in the City Hall and a concert in the City Theater. Address of welcome by Mr. van Tilburg, Deputy Burgomaster. Answering address by Prof. K. Terzaghi.

#### Friday June 25.

9.30 - 12.00 Fifth meeting. W.J. Turnbull presiding.  
 9.30 - 10.00 Lecture by Ir. H.A.M.C. Dibbits on road construction on soft subsoils.  
 10.00 - 12.00 Opening discussion by the reporter G. Wilson on section VIII and IX on roads, runways and soil stabilization. Discussions with closing remarks by Prof. Terzaghi.  
 14.00 - 16.30 Sixth meeting. L.F. Harza presiding.  
 14.00 - 14.30 Lecture by Ir. T.K. Huizinga on the geology of the Netherlands in connection with soil mechanics.  
 14.30 - 16.30 Opening discussion by the reporter R. Ruckli on section I on theoretical subjects. Discussions with closing remarks by Prof. K. Terzaghi. The ladies made a trip to the Westland to visit nurseries and auction of flowers, vegetables and fruit.  
 17.00 - 18.00 A meeting of European members took place to discuss the proposals of Golder and Glossop for the possibilities of an European Society on Soil Mechanics and to stimulate the collaboration between them.  
 21.00 - 23.00 Official reception of the members by the Government at The Hague in the Kasteel Oud Wassenaar. Address of welcome by Mr. J. in 't Veld, Minister of Housing and Reconstruction.

#### Saturday June 26.

9.30 - 12.00 Excursion to the tunnel under the river Maas at Rotterdam.  
 14.00 - 15.00 Final meeting. Prof. K. Terzaghi presiding. Address by Prof. K. Terzaghi.

16.00 - 17.30 Official closing of the Conference in the Palace Theater Rotterdam. Ir. J.P. van Bruggen presiding. Address by Prof. K. Terzaghi. Closing remarks by Ir. J.P. van Bruggen.  
 20.00 Farewell dinner at Hotel Kurhaus Scheveningen. Farewell address by Prof. K. Terzaghi.

#### Sunday June 27.

7.45 - 18.30 Excursion along the roads and polders of the province of North Holland. A visit to the old polders and the new Wieringermeer polder and to the dike closing the Zuiderzee with its dewatering - sluices and shipping locks. The route was taken through some old picturesque towns and along an old dune country

#### Monday June 28.

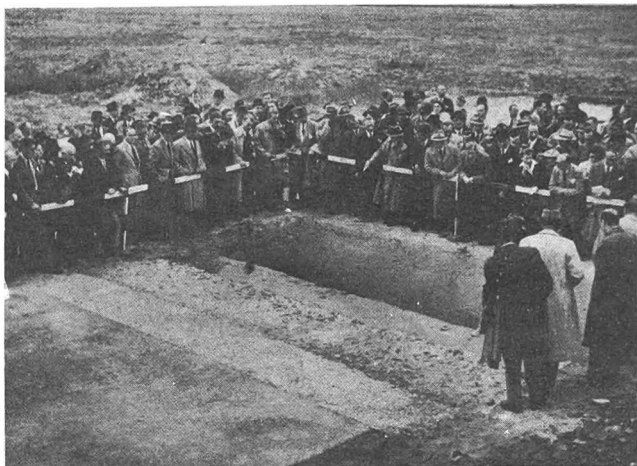
9.00 - 18.00 Excursion to Amsterdam with a boat trip through the old canals and the harbour of the town. Reception by the Municipality of Amsterdam with a lunch in the principal building in construction on the Schiphol Transoceanic Airport. Visit to the airport where the extension works and the "sandwich" runways were shown. The return trip was made along the rivers Vecht and Oude Rijn with their lovely old country houses.

#### Tuesday June 29.

9.00 - 18.00 Excursion by boat along the reconstruction works of the harbour basins of Rotterdam, followed by a trip on the Dutch tidal rivers where some large bridges were passed. Visit to a typical Dutch landscape with more than 20 windmills.

#### SUGGESTIONS FOR FOLLOWING CONGRESSES.

The Organizing Committee and especially the Editorial Board have experienced some difficulties well deserving to be pointed out. Although the bulletins issued by the Com-



Sandwich construction, Schiphol Airport.



Farewell after the last boat trip.

mittee contained several suggestions to the contributors of reports regarding the quality of drawings etc., these suggestions in many cases were disregarded. As this caused much trouble extra work and delay, first of all the instructions for the authors should be more precise so as for the sizes of drawings and photos, the thickness of the lines and the sizes of the letters. Drawings in the purest white and black are by far the best for reproduction. The recording of literature references should be normalized.

Secondly the classifying of the contributions in accordance with the Sections indicated in the program proved to be difficult. Especially section I on theoretical subjects should be divided e.g. in 3 sections containing: general considerations; classification, physical and physico-chemical properties; soil mechanical theories. One contribution should only go into one section or should be divided into more than one.

As the price of the Proceedings and the possibility to have these printed in time depends on their number and their bulk, it is necessary to know the number of contributions and of subscribers at an early date. The National Committees can be of great help to the Organizing Committee in obtaining these data.

During the Conference it turned out due to a large number of discussions that the time available was rather short. It is suggested that in further conferences more time should be allotted for this purpose.

Last but not least it should be pointed out that the success of a Conference depends to a large degree on the timely publication of the Congress reports that are to be discussed. Therefore contributors of reports cannot be urged too much to have their contributions available for reproduction at the date

fixed by the Organizing Committee.

#### ACKNOWLEDGEMENTS.

The Organizing Committee wishes to express its special gratitude to the Netherlands Government; the Municipalities of Rotterdam and Amsterdam; the Netherlands Railways and many other officials for their great help in organizing the Second International Conference on Soil Mechanics and Foundation Engineering.

It is a pleasant duty, to thank all the members of the different committees for their endeavour and enthusiasm. The splendid success of the Conference was primarily due to the intense and hearty cooperation of all the members.

Further the success of the Conference was in a large part due to the work of its President Prof. K. Terzaghi, who has given stimulating interest in our branch of knowledge in his lectures and discussions. His discussions will give rise to more international collaboration on different research problems.

All who participated the Conference will agree with a special word of gratitude to the Chairman and the General Reporters who have fulfilled their difficult task in such a splendid fashion. The work, the general reporters have done in a rather short time, due to the overwhelming number of contributions who came in mostly at a very late date, has our whole admiration.

The Proceedings were printed by Gebr. Keesmaat, Haarlem according to the Planograph process. Considering the unusually short time which was available for the printing of the first five volumes and the inhomogeneity of the contributions, especially the size and execution of the drawings, their appearance has been made very satisfactory.

Delft, the Netherlands,  
October 1, 1948

Ir. T.K. Huizinga,  
Secretary to the  
Conference



FINANCIAL REPORT

The number of participants of the Second International Conference on Soil Mechanics and Foundation Engineering was 596, that of the Second International Conference on Underground Town Planning 109, of which in total respectively 147 and 12 ladies.

ference has been fixed so, that the printing costs, the transport and the assurance were included. It will be worthwhile to memorate, that besides the costs of the Editorial Board additional costs up till approximately f 6000 were paid for corrections and drawing work.

Registration fees Soil Mechanics	8316.51	
Registration fees Town Planning	1130.--	
Meetings		9499.80
Dinners and Receptions	6890.55	8298.75
Excursions	11675.--	9145.13
Information offices		591.75
Secretariate		4518.63
Printed matters, stamps, etc.		8152.15
Various		681.86
Deficit	12876.01	
	40888.07	40888.07

In the above mentioned costs the salaries of the members of the various organizing committees and subcommittees are not included, as they were carried by the various Directions to which these members belong.

The price of the Proceedings of the Con-

The number of Proceedings printed was fixed after having made an inquiry by the National Committees about the required number. At this moment about half of the estimated numbers is ordered and expedited.

Ir. W.C. van MIERLO, Treasurer.

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ADDRESS AT THE OPENING SESSION, TUESDAY JUNE 22, 1948

IN THE CITY THEATER, ROTTERDAM

OPENING ADDRESS

Ir. J.P. van BRUGGEN

Mijnheer de Vertegenwoordiger van H.M. de Koningin, Excellentie, Mijne Heren Leden van het Erecomit  voor de tweede Internationale Congressen voor Grondmechanica en voor Ondergrondse Stedenbouw.

De Commissie, belast met de organisatie van evengenoemde Congressen, is dankbaar, dat H.M. onze ge erbiedigde Koningin het Beschermvrouwschap dezer Congressen heeft willen aanvaarden en zich op de Openingszitting wel heeft willen doen vertegenwoordigen. Een nadrukkelijker bewijs van de belangstelling, die H.M. voor de technische wetenschappen koestert, zou, in het bijzonder wel aan de buitenlandse deelnemers dezer Congressen, niet gegeven kunnen zijn.

De Nederlandse Regering en het Gemeentebestuur van Rotterdam hebben, door het Permanent Comit  voor Internationale Congressen voor Grondmechanica en Funderingstechniek en het Permanent Internationaal Comit  voor Ondergrondse Stedenbouw uit te nodigen beide hun eerste na-oorlogse congres in Nederland, en met name in Rotterdam te houden, er blijk van gegeven, van hoeveel belang zij het achten, dat een aantal van de meest vooraanstaande beoefenaren der bouwtechnische wetenschappen uit het buitenland in de gelegenheid zouden zijn, zich in ons land op de hoogte te stellen van de pogingen om ons te herstellen van de oorlogsverschikkingen en van de wetenschappelijke hulpmiddelen, die wij daarbij te baat nemen. Het is der Commissie voor de Organisatie een voorrecht, op grond van die uitnodigingen tot haar taak geroepen te zijn. De Commissie waardeert het bijzonder, dat Gij, Excellentie en Mijne Heren, door toe te stemmen in het aanvaarden van een plaats in het Erecomit  en door Uw aanwezigheid hier, het zoeven genoemde belang nog hebt willen onderstrepen. U allen moge ik dan ook namens de Commissie voor de Organisatie hartelijk welkom heten.

M. le Doyen du Corps Diplomatique,

En souhaitant dans ce qui pr c dait, la bienvenue aux membres du Comit  d'honneur, je me suis adress  aussi   vous, quoique en langue diplomatique. Je tiens   vous dire encore, au nom du Comit  d'Organisation des Congr s, comment votre pr sence est appr ci e dans cette assembl e internationale et comment elle en souligne l'importance.

Ladies and Gentlemen,

The Committee on Organization of both the Second International Conference on Soil Mechanics and Foundation Engineering and the Second World Conference on Underground Town Planning and Construction, extends a cordial welcome to the Netherlands to all of you. The Committee highly esteems that a number of you have been appointed as official delegates of foreign Governments or scientific Societies, thus accentuating the importance of these Congresses. A special word of welcome goes to the ladies

accompanying the foreign Congressists. The Committee hopes that during the hours that their relatives are engaged on Congress matters, the Netherlands may show them to possess some attractions worth being visited.

The rapid developments of science and the rise of quite new branches of engineering knowledge made it desirable some ten years ago to bring together as well the engineers and architects, interested in soil mechanics, as those engaged on underground town planning. International Congresses were held, for soil mechanics in Boston, for underground town planning in Paris and in both cases they were considered of such value, that Permanent Committees were set up in order to facilitate the organization of further international contacts.

Unfortunately the Second World War interrupted their activities for a good number of years, but when circumstances again looked favourable, pre-war plans sprang up anew. Assuming that architects and engineers interested in branches of knowledge falling within the scope of the aforementioned Congresses, would also appreciate an opportunity to hear and see something about the ways in which post-war engineering problems are handled in this country, the Netherlands Government and the Municipality of Rotterdam have invited both Permanent Committees, to hold their Second Congresses in this city.

These invitations accepted, the Committee on Organization thought it wise to combine the two Congresses, as it supposed that there would be a number of participants interested both in subjects treated in the Soil Mechanics Conference and in subjects, considered in the Underground Town Planning Conference. We earnestly hope that the program, elaborated for both Conference with this in mind, may obtain the approval of the members involved.

The Committee has noticed with great joy that its international communications have met with a lively interest. The number of participants is considerable and the reports outnumbered any estimate made in advance. Although this demonstrates the widespread desire for renewed international contact, it put the Committee before serious problems. These problems will be understandable when it is considered that the time elapsed since the end of the war is relatively short and that consequently our totally pillaged, ruined and impoverished country is still engaged on re-equipping itself with almost everything. If therefore you find things not up to the standard you are accustomed to at home, the Committee pleads for some consideration.

Nevertheless the Committee hopes that these Conferences may prove to be fruitful, not only for the promotion of science, but also for the promotion of international and personal relations.

Whatever is reached in this respect will add to the wisdom and mutual understanding the world needs so badly just now.

OFFICIAL OPENING

Dr. Ir. W.J.H. HARMSEN

Mr. President, Ladies and Gentlemen.

It is a great privilege to me to have been charged by His Excellency the Minister of Transport and Public Works to address this audience.

The Netherlands Government highly appreciates the fact that two important conferences, one on Soil Mechanics and Foundation Engineering and one on Underground Town Planning and Construction have decided to meet in our country.

The subjects to be discussed by both conferences have many mutual points of contact. They have moreover in common that they are of primary importance to the actual reconstruction of the areas that have been damaged by the war.

In this connection the fact that one of the most badly damaged cities of the Netherlands has been chosen as the meeting-place for these two conferences has symbolic significance.

As you Mr. President have already mentioned this is the second time that an international conference on soil mechanics and foundation engineering is held. But for the war, this second conference would have taken place in 1940. At the first conference it was already evident that many people in the Netherlands were deeply interested in this part of technical science.

We need not be surprised at this. The greater part of our country offers foundation problems to the constructing engineer. The most densely populated area is situated in the alluvial north and west of our country. The soil here generally consisting of sometimes thick layers of peat and soft clay resting upon a more stabile layer of sand at greater depth, does not allow buildings of some weight to be erected without expedients as to their foundation. As soon as in these parts the original buildings of wood were replaced by those of masonry our ancestors were forced to go in search of means to reach the deeper more resistant layers. It may be said that in our country foundation on wooden piles has for centuries been the traditional method of founding. An old nursery rhyme tells us that Amsterdam,

that large town, has been built on wooden piles. In order to give our schoolboys and -girls an impression of the important dimensions of the old Amsterdam town hall built in the 17th century and now serving as a royal palace, they were taught that it is founded on 13,659 piles.

Not only the construction of buildings however causes in this part of our country much trouble on account of the soft subsoil, but also the construction of dykes and roads provides many difficulties. Here also various means have been applied, such as fascine work of the same nature as used in hydraulics. Of course many failures were the cost of the experience acquired in course of time.

Fortunately at present we need not only rely on the experience gained from comparison with similar cases in our problems on the foundation of buildings, dikes, roads, etc., but we can now be guided by contemplative science, laboratory experiments combined with observations of existing objects. In the present period of reconstructing on a scale unequalled before, the progress of the knowledge of soil mechanics and foundation engineering is of primary importance.

We are more than ever forced to consider the best construction justified and first of all the starting-point, the foundation.

Ladies and Gentlemen,

I hope that the time our guests will pass together in our country will be of lasting value to them and that they may have pleasant memories not only of the fruits of your labour but also of our country and their stay here.

Mr. President,

Answering your invitations and in the name of His Excellency the Minister of Transport and Public Works I declare the 2nd Conference on Soil Mechanics and Foundation Engineering and Underground Town Planning and Construction opened.

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## OPENING ADDRESS

Prof. K. TERZAGHI



### SOIL MECHANICS 1936 to 1948.

When the First International Congress on Soil Mechanics and Foundation Engineering was held in June 1936 in Cambridge, Mass., all the participants looked forward to an area of peaceful development and international cooperation in the forging of a new and efficient tool for the practicing engineer. The cornerstone was laid for an international organization, embracing all the national groups of workers engaged in the pursuit of soil mechanics, and it was decided to meet again in four or five years in the city in which we meet today, to review the results of our efforts and to decide on the strategy for the future.

At that time, when we were happily assembled on the campus of hospitable Harvard University, nobody suspected what was in store for us. Three years after the conference in Cambridge, Mass., humanity was dragged into a bloody conflict which soon engulfed the whole globe. As a consequence all of us were compelled to live and work under the severe restrictions imposed upon engineering and research activities by wartime conditions, and the free interchange of thought and experience was interrupted during a period of many years.

In spite of these handicaps an impressive wealth of new and valuable information was gathered in every part of the world, as testified by the contents of the papers submitted to the conference. This fact demonstrates convincingly that soil mechanics responds to a vital need of the engineering profession.

The Proceedings of the First Conference gave us a bird's-eye view of the methods which were used or proposed, before 1936, for securing information concerning the conditions for the stability of bodies of soil and the behavior of soils under load. Therefore it seems appropriate to start the Second Conference with a review of the successes and failures which were experienced with these methods, during the last decade.

### FUNDAMENTAL RESEARCH

Every science, pure or applied, is based on what is known as fundamental research. Prior to 1936 fundamental research in soil mechanics consisted chiefly in the investigation of the significant soil properties by laboratory tests, and in the development of theories of earth pressure, stability and settlement. In 1936 this pioneering stage of

soil mechanics research was already completed. It had created what may be called an ideal pattern of soil behavior and it had placed at the disposal of the practicing engineer a set of theoretical concepts covering every important field of soil behavior. The concepts were based on the laws of applied mechanics and on the results of laboratory tests performed under rigidly controlled conditions on soil samples which were believed to be almost undisturbed.

In order to compare the theoretical forecasts with reality an increasing number of accurate measurements of the settlement of full-sized structures and of the pressures on earth supports were made. Thus it was found, even before the First Conference in 1936, that the forecasts pertaining to the behavior cohesionless soils were essentially correct, whereas in the realm of clay behavior, various discrepancies between forecast and reality were noticed. Considering the existence of these discrepancies, I issued, at the close of my opening address in 1936, an emphatic warning against indiscriminate extrapolation from findings to field behavior.

Discrepancies between forecast and reality can be due either to erroneous assumptions or to errors in the deductions. There was no flaw in the reasoning which led from the test results to the conclusions. Hence we were compelled to conclude that the discrepancies were due to an important difference between the performance of clay under laboratory conditions and in the field. On account of this fact it was obvious that a radical departure from the original technique of fundamental clay research was indicated. The departure involved intensified observation of the behavior of clay under field conditions and modification of our concepts in accordance with the findings. Compared to this task all the other types of fundamental soil mechanics research such as refinements of our theoretical methods and laboratory techniques became issues of secondary importance.

As the years went by, the number of known discrepancies between the real and the ideal pattern of clay behavior increased. Thus, for instance, it was observed that the elastic deformations of natural bodies of clay are commonly very much smaller than those computed on the basis of the elastic constants of undisturbed samples. It was also noticed that the relation between water content and overburden pressure for normally consolidated clays can be very different from the results of our consolidation tests in the laboratory may lead us to expect.

The investigation of the shearing resistance of clays also revealed various disturbing contradictions between laboratory and field behavior. Slide phenomena were encountered which cannot yet be satisfactorily explained and the effects of pile driving on the compressibility of clays continued to be a controversial issue. Experience indicates that it can be very different for different clays, but we are not yet in a position to predict these effects by means of laboratory tests. In our dealings with swelling clays we realized that the behavior of these clays also depends primarily on factors which cannot be determined by means of laboratory tests.

All these and various other observations convey the impression that the properties of undisturbed clays are more complex than laboratory tests on undisturbed clay samples indicate. In addition to the properties disclosed by the laboratory tests every natural clay stratum seems to possess a personality

of its own. Part of it is determined by the conditions under which sedimentation took place and the balance developed in the course of time under the influence of the chemical environment in which the aging occurred. During the processes of sampling and transporting some of the essential features of the clay are destroyed and, as a consequence, the laboratory tests disclose only one part of the real character of the material. The real character can only be discerned by carefully observing the performance of the clay in the field and comparing the results with predictions based on laboratory tests. Hence the further advance of our knowledge in soil mechanics depends to a large extent on the scope and the quality of our field observations.

#### TECHNIQUE OF FIELD OBSERVATIONS.

Field observations may serve one of several entirely different purposes. They may be required to check our theories and to detect important differences between the behavior of soils in the laboratory and in the field; they may be used for collecting information regarding phenomena, such as the creep of clay under load, the gradual increase of the pressure of cohesive soils on rigid subsurface structures or the consequences of the disturbance of the structure of fine-grained soils by pile driving, which cannot reliably be reproduced in the laboratory. Last - but not least - they may be used to find out during construction whether the assumptions on which the design was based are reasonably correct. If serious differences are detected the design can be adapted to the existing conditions.

During the last decade the technique of field observations has received considerable attention. In the Netherlands and in the U.S.A. the means for measuring the porewater pressures in clay have been improved and the Proceedings of this Conference contain several papers on the results obtained by these means. In the open cuts and tunnels of the subway of Chicago extensive measurements have been made of the pressures exerted by clay on temporary supports. In France, during the war, notable progress was made in the technique of determining the initial stresses in strata of heavily precompressed swelling clays.

As a result of all these developments our knowledge of the behavior of fine-grained soils under field conditions has increased considerably. Nevertheless, several of the most important methods, such as those for measuring the porewater pressure in clay and the pressure of clay on retaining walls, still leave a wide margin for improvement.

#### SUBSURFACE EXPLORATION.

In order to apply our theories directly to the design of foundation and subsurface structures it is necessary to secure as complete information regarding the physical properties of the subsoil as our methods of sampling and testing permit. On account of this necessity the technique of sampling has been brought during the last decade, chiefly under the auspices of the Soil Mechanics Division of the Am. Soc. of C.E., to a high degree of perfection. However, at the same time, it became evident that fairly homogeneous soil deposits are very rare and all our theories are based on the assumption that the subsoil is either homogenous or that it consists of a small number of homogenous strata. This is one of the reasons why it is so difficult to find out, by observation on full-sized struct-



ures, the degree of accuracy of our theories. If the structure of a subsoil is erratic, design can be based only on semi-empirical rules. The estimate of the settlement of footings or rafts on sand on the basis on the results of standard penetration tests in exploratory drill holes is an example of this type of procedure.

Design on the basis of semi-empirical rule does not require numerous and elaborate soil tests because the results of such tests would not increase our capacity for coping with our problems. It is sufficient to determine approximately the significant properties of one or two dozens of representative samples. Our main efforts must be concentrated on unravelling the structural pattern of the subsoil and on locating its weakest and strongest spots. At the present time this can be done by combining exploratory borings with one of the penetration methods which have been developed independently, during the last decades, in the Netherlands, Belgium, Denmark, Sweden, Switzerland and the U.S.A. The extrapolation from the data obtained by the field tests to the performance of the full-sized structure is made by means of statistical relations combined with theoretical considerations.

#### REGIONAL DEVELOPMENTS.

In order to establish statistical relationships it is necessary to correlate the results of penetration tests or equivalent data furnished by the subsoil exploration with the performance of the full-sized structures. However, the statistical relationships disclosed by such operations inevitably involve a considerable scattering from the average, and empirical rules based on such relationships should not be trusted unless the range of scattering from the average is known. Therefore satisfactory semi-empirical rules cannot be derived from two or three of observations. It is necessary to secure and digest one or two dozens of case records for each one of the principal types of soil. The opportunity for securing such a large number of records can be found only where fairly well-defined soils or combinations of soils prevail, either beneath an area occupied by a large city or beneath a broad region on a continent. Thus for instance, the London clay, the Boston blue clay, the Chicago soft clay, the stiff, swelling clays of Paris, and the extensive sand deposits in the subsoil of Berlin are well explored because they occur beneath large cities; and the properties of the varved clays of New England and the thick layers of residual soils derived from the decomposition of gneiss and granite in southern Brazil are well known, because they cover very large areas and were encountered in numerous construction operations.

If an engineer is compelled to conduct a great variety of construction operations in or on a geologically well-defined soil deposit he will soon become familiar with all the details of the personality of the soil. As a consequence he has an opportunity to develop, by trial and error, methods of subsoil exploration which provide him with the greatest amount of useful information which can be secured at a tolerable expenditure of time and money. This will be his contribution to applied soil mechanics. If he strikes, on one of his jobs, another type of soil for the first time, he will avail himself of the experiences of those among his fellow engineers who were compelled to deal with this soil many times before. Hence the geographic distribution of the principal soil types alone calls for regional development and for inter-

change of regional experience on an international scale. The procedures growing out of the regional developments will depend to a large extent on the degree of uniformity and continuity of the prevalent soil strata.

If Nature was considerate enough to bury the rock surface under a blanket of fairly uniform clay or a succession of continuous clay and sand strata, the engineer will concentrate on developing his methods of sampling and testing and he will indulge in the luxury of practicing his theories of settlement with justified hopes for a fair agreement between forecast and reality.

If the soil profiles in his domain are very irregular he will soon tone down his ambitions. He will secure approximate data regarding the compressibility of the major bodies of soft soil located beneath his sites. He will design his structures in such a manner that the maximum settlement will be tolerable but he will realize that it is impracticable to predict the distribution of the settlement over the loaded area and he will adapt his program of subsoil exploration to this fact.

Finally, if he is compelled to deal with those erratic accumulations of loose and dense silt, sand, silty sand and gravel which occupy river channels or the marginal zone of Pleistocene ice sheets, he will be content to perform the penetration tests, supplemented by a few exploratory borings, and he will make his design on the basis of statistical relations between penetration resistance, size of loaded area and settlement.

Thus the program of subsoil exploration represents the result of a compromise between what is desirable and what can be achieved at a reasonable expenditure of time and money. The general procedure is dictated by the purpose of the investigation, but the details can be worked out only by trial and error. They are governed by the structural pattern of the subsoil subject to exploration which, in turn, is determined by the geologic history of the deposits.

#### GEOLOGIC ASPECTS OF SOIL MECHANICS.

The structure of fluvio-glacial outwash is entirely different from that of an alluvial fan, a seashore deposit or of a delta, although the types of soil contained in these deposits may be very similar. Both flood plain and lake deposits may consist of fine, silty sand and clay, but the soil profiles may have little in common. Exploration of these deposits by means of the same procedure would be utterly wasteful. Each one calls for a different technique. These techniques are being developed simultaneously but in different parts of the world, and each one of them is linked up with a product of well-defined geologic processes. Hence the different procedures of subsoil exploration can be utilized to full advantage only if they are linked up, in the mind of the practicing engineer, with geologic concepts.

Substantial benefits have also been derived during the last decade from an intensified study of the topographic details of the scene of proposed construction operations because the geologic and physical character of the subsoil are reflected by both the salient features and the details of the surface topography. Investigations of this type have been successfully made for the purpose of selecting sites for airdromes and highways and for locating deposits of suitable construction materials. The technique consists in analyzing the topographic details recorded by aerial photography. It is described in one of the contributions to

this conference.

The most important areas of contact soil mechanics and geology are encountered in connection with problems involving the stability of slopes and the foundation of storage dams. The majority of failures of slopes and of dam foundations are due to the seepage pressure of percolating water. In order to prevent such failures, slopes must be drained and the water which escapes from the reservoir through the subsoil of storage dams must be diverted toward filter wells or the base of filter blankets. The water may travel over long distances along lines of least resistance whose location can hardly be ascertained by means of test borings, and the hydrostatic pressure conditions in the porewater of the soil adjoining a slope or of the subsoil of a dam depend on the geologic structure of the entire region surrounding the site. Therefore it is no exaggeration to claim that a large slide area cannot be properly treated and the foundation of a dam on permeable substrata cannot be adequately designed without careful consideration of the geological character not only of the site itself but also of its environment.

In view of the variety and importance of the influence of geologic factors on the performance of the soils in the field and on the methods for predicting their performance, the boundary between soil mechanics and engineering geology appears to be rather artificial. Today our techniques for subsoil exploration are still in an incipient state. The tendency is and must be to develop very different techniques, one for each of the principal patterns of subsoil structures and the choice between them will be determined by the geologic character of the site. Hence the time may come when it will be appropriate to combine soil mechanics and engineering geology into one unit, under a name such as "Geotechnology" which was appropriately selected by our British colleagues as a title for the first journal covering our field of interest. This glance into the future leads up to a review of the trends of our endeavors.

#### OUTLOOK.

During the twelve years which have elapsed since the last international conference on soil mechanics it became even more evident than it was before the conference that the practical application of soil mechanics requires a compromise between the methods of exact sciences such as the theory of structures and those of the empirical ones, like geology.

The days in which significant discoveries

could be made in the laboratory, or at the writing desk, appear to be gone forever. Further progress depends chiefly on the improvement of our methods for measurements in the field, on the scope and the quality of the field observations and on the adaptation of our methods of subsoil exploration to practical requirements. To calibrate the results of our exploratory operations such as penetration tests and to increase the usefulness of our semi-empirical procedures we need for each one of the principal types of soil and composite soil formations a great number of complete and reliable case histories which inform us on the reactions of these formations to changes in stress due to excavation or load application. For each type of soil such histories can be secured only where the soil prevails over large areas. This fact alone calls for a division of labour in a geographical sense.

We must expect the engineers of the Netherlands to advance our knowledge of cohesionless soils and of soft organic clays, because they encounter these soils more often than anybody else; it is the task of the engineers in Sweden, in the Northern United States and in Canada to explore the intricate properties of varved clays, and of those in Brazil to provide us with information concerning residual soils. Each one of these groups will be compelled, in its own interest, to adapt its methods of subsoil exploration to the structural characteristics of the soil formations which prevail at the sites of their construction activities. If, then, an engineer in another country encounters for the first time a soil condition which is commonplace in Holland or Brazil, he will have at his disposal procedures which are based on extensive experience in dealing with such conditions.

In this manner - and only in this manner will we be able to develop soil mechanics into an efficient tool for the practicing engineer in spite of the severe limitations which Nature has imposed upon the use of purely theoretical methods and of laboratory procedures in our field of endeavor. As a matter of fact, I myself and, I am sure, many among you cherish these limitations. Concrete and steel design and many other branches of engineering can be practiced by experienced men in a routine fashion. By contrast, in the realm of earthwork engineering every new job involves at least some minor features which are without precedent. These features keep us alert regardless of the scope of our experience in space and time, and the lure of the unexplored never wears off.

## FINAL MEETING OF THE CONFERENCE

PRESIDENT

I call the meeting to order.

The first point on the program consists in formulating the conclusions to which the four sessions have led. In my opinion the conclusions are implicitly contained in the general report, in the discussions and in the closing remarks of the general reporter. Therefore it appears indicated to follow the example which was set by the Congress on Large Dams. Every general reporter simply added to his closing remarks a brief statement of all the unanimous opinions concerning the subject of his general report. If he felt inclined to do so he could also add conclusions of his own, but he had to emphasize that they were not shared by all the participants of the Congress. This appears to be a satisfactory procedure.

(The procedure was approved.)

Mr. de Nis requested permission to make a few remarks in connection with the conclusions and I ask him to come to the platform.

Ir. F.C. de NIS

Prof. Bretting and I as the reporter and assistant reporter of the first meeting of this Conference have the task, according to the "guide" for the reporters submitted to us before the Conference to draw up a concept resolution, if deemed fit, which in this meeting should be put to the vote.

Looking back to the discussion of the first meeting Prof. Bretting and I considered it difficult to draw such a resolution as no final decision could be taken in any problem, that was being discussed at the meetings. For instance in the question of the value of the lateral earth pressure speakers were not unanimous. Although the opinion of the different speakers does not lie so far apart as it seemed on that first meeting, I noticed that even yesterday evening Prof. Tscheborarioff and Mr. Brinch Hansen were still arguing about the question. Of the other uncertainties in soil mechanics knowledge, that became apparent in this Conference, I will only mention to you the question of the shearing resistance.

I hope I am right in stating that our English friends are convinced, that the shearing resistance is one half of the unconfined compression strength, and they have obtained good results in making their calculations with the  $\phi = 0$  method.

They dislike our quickly or slowly performed triaxial test, stating that by that test a result is obtained which depends largely upon the circumstances in which the sample is during the test. I think I am justified to say that this is also our point of view concerning the cell-test since about 1937. Considering this we execute the test in the most unfavourable conditions, to obtain a minimum or maximum value for the so-called shearing strength.

Our believe however is, according to the statements of my former colleague Mr. Geuze on Thursday afternoon, which were alas cut by the intervention of the red light, that no such a constant as the shearing resistance exists, but that the soil deformations are

growing with the increase of shearing stresses, until rupture takes place.

One could therefore very well imagine a case in which not all of the available so called shearing strength i.e. the shearing strength at rupture, could be utilised.

I have no doubt that every one of you could add many problems in the field of soil mechanics to those here mentioned.

I presume that none of you here present is not aware of the fact that a great deal of work is still to be done to enlarge our knowledge of soil mechanics so that we might have more valuable information before starting the construction of works.

The time is over when with such humble means as an old tin biscuit box, a cord, a bicycle wheel or a couple of pins we could bring forward the knowledge in this field. With the growth of our knowledge the apparatus for the investigation became more and more complicated as you will have noticed during your visit to the "Laboratorium voor Grondmechanica" at Delft where you will have seen for instance the sorption apparatus, the automatic volume regulating consolidometer for the measuring of pore pressure during consolidation or the fine radio-sets as I might call them, for investigation of the dynamic properties of soils.

Not everyone is fully aware of the difficulties in enlarging our knowledge, as for instance was that physical engineer who said to me: "I do not see the difficulties in soil mechanics. You have only to draw up the appropriate differential equation for every problem and solve it to be able to calculate all you want."

Although in our present state of knowledge we can give some valuable qualitative information on soil mechanics problems, the possibility of giving quantitative information is still far away in many questions.

Sometimes the consideration is heard, that in our present state of knowledge we can handle most of the problems that are usually to be dealt with, but I do not consider this as a most scientific state of mind. Much more I am liable to apply an old Dutch saying to this point of view which says: arrest is decline.

And I think that all here present will be able to agree to some extent with my resolutions. You will perhaps have the opinion, that they are bringing water to the sea, but now I leave it to you if you will accept, amend or reject them.

The second Conference on Soil Mechanics and Foundation Engineering in its final meeting on Saturday 26 June 1948 considering the many soil mechanical problems, that are as yet fully or partly involved has drawn up the following resolutions.

1. The consulting work in soil mechanic laboratories should be done in close coöperation with the engineers who are in charge of the design and execution of the work in question to be sure of the greatest possible efficiency of the advise.

2. Soil mechanic forecasts should always be checked afterwards with the real outcomes obtained during and after the execution of the respective work.

3. It is considered of the utmost importance to promote the organising and execution of research work on all problems in soil mechanics.

#### PRESIDENT

The three points covered by Mr. de Nie's draft for a resolution have already been brought out in my opening address and by various other speakers at the first Conference in 1936. They have dominated the trend of soil mechanics research for more than a decade and they are self-evident to everybody associated with soil mechanics. Therefore I doubt the necessity of restating them once more in a formal resolution.

The second point on our program is Mr. Eskalis' proposal that the International Society should make provisions for promoting and facilitating personal contacts between members during the periods between congresses. I discussed this topic with Mr. Huizinga and we make the following suggestion. As soon as possible, before the end of October of this year, the chairman of every national committee should send to the secretary of the executive committee a list of all the members of his committee together with their addresses and professional affiliations. The secretary will assemble

the data, have them printed, and each national committee assumes the responsibility of paying its share in the costs of printing in U.S.A. currency.

In the letter accompanying the membership list the chairman of each national committee specifies the number of membership lists which he wants to receive. The ratio between this number and the total number of copies determines the share of his committee in the costs of printing. The membership lists will be mailed to each national committee as soon as the payment is received.

(The proposal was accepted).

Since the proposal is accepted, a paragraph concerning the membership lists will be introduced into the statutes.

The third and last point on our program is the preparation of soil mechanics dictionaries. Mr. Huizinga has prepared such a dictionary for Dutch engineers. One column contains the English terms and the second one the equivalent Dutch terms. One copy will be sent to the chairman of each national committee to serve as a prototype. It is suggested that all the national committees using the same language should appoint a committee on nomenclature and prepare for their language a dictionary similar to the Dutch one.

(The proposal was accepted and the meeting was adjourned.)

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## ADDRESSES AT THE OFFICIAL CLOSING OF THE CONFERENCE

CLOSING ADDRESS

Prof. K. TERZAGHI

It is most appropriate that the closing address of the spokesman for the International Conference on Saturday afternoon should follow that by the President of the Conference for Underground Town Planning, because soil mechanics is decidedly a junior partner in the old and well-established group of disciplines which constitute Municipal Engineering,

The town planner is a man with creative imagination. He visualizes a super-organism with veins, arteries and a highly developed nervous system and he prescribes how it should function. The municipal design engineer converts the vision into something more tangible, with three dimensions, and the contractor turns the image into reality.

However, doing the job is one part of the problem only. The other part consists in doing the job in such a manner that the existing constituents of the municipal organism should not be damaged, and the meaning of the term "damage" is extremely vague. This is demonstrated by the records of the lawsuits which commonly follow large municipal construction operations such as the construction of subways.

In the good old days of municipal engineering the means for the prevention of damage were chiefly a matter of judgment. The ways of judgment are as mysterious as those of providence and everybody knows that providence is occasionally absent-minded. No reliable information was available regarding the strain effects of excavation operations. It was commonly assumed that a well-designed foundation does not settle at all and, in a similar manner, it was also assumed that one could construct an open cut or a tunnel without producing a settlement of the ground surface. Settlement with detrimental consequences was considered a symptom of poor workmanship or, if the contractor was lucky, it was classified as an act of God.

Soil mechanics has radically changed this condition. It has demonstrated that no excavation can possibly be made without preceding settlement of the adjoining ground surface and it has provided us with detailed information regarding the factors which determine the magnitude and the distribution of the settlement. Thus the prevention of damage to adjacent property was lifted out of the realm of pure judgment and transferred into that of rational procedures. During the construction of the subway of Chicago, the fundamental principles of these procedures have successfully stood

the crucial test of practical application and the technique have passed from the experimental state into that of maturity.

In exchange for the services which soil mechanics has rendered to the municipal engineer, the municipal jobs have offered to soil mechanics a unique opportunity for observing and measuring the reaction of natural bodies of soil to local stress relief due to the excavation of tunnels and open cuts. The results of these observations have provided us with an insight into the stress-strain relations for undisturbed cohesive soils which could not possibly have been obtained by any other means. The exchange of information of this kind is one of the requisites for the advancement of soil mechanics. Yet, originally, soil mechanics was carried on in isolated research centers. In 1936, at the First International Conference on Soil Mechanics and Foundation Engineering in Cambridge, Mass., the first attempt was made to coordinate the individual efforts and to establish an international organization for the interchange of thought and experience in our field of endeavor. Since the second world war interfered with our design, we accepted the invitation of the Netherlands Government to meet again and to resume cooperation on an international basis.

Owing to the skill and the untiring efforts of the organizing committee and to the enthusiastic cooperation of the members, this second conference was as unmitigated a success as the first one. Both the contributions and the discussions were on an exceptionally high level. The statutes of the permanent organization were revised to fit the abnormal economic conditions which prevail since the second world war, and provisions were made to bridge the gap between successive conferences by the annual interchange of vital information. The contributions of the foreign members of the conference were supplemented by lectures which gave us a bird's-eye view of the manifold construction problems confronting our colleagues in the Netherlands and the Proceedings of the conference were impeccably edited and printed.

All this we owe to the organizing committee. Therefore, I wish to convey to Mr. Van Bruggen, chairman of the committee, to Mr. Huijzinga, secretary, and to the members of their staff, the expression of the deepest gratitude of all the National Committees represented at this conference.



CLOSING ADDRESS

Ir. J.P. van BRUGGEN

Professor Terzaghi,  
When, during the preparation of this Soil Mechanics Congress, I had the occasion to acquaint myself with the report, sent in from all over the world, I was not only impressed by their number, but still more by their excellent presentation and their wide variety of interesting subjects. My expectations of this Congress therefore were pitched high and I presume this will have been the same with all members. There has been no reason for disappointment, on the contrary: from beginning to end this Congress has proved the value of present-day Soil Mechanics in civil engineering problems. Your summary and perspective have thrown clear light upon these facts and I am sure I speak in the name of all present when, come to the end of our scientific work, I not only thank you for this fine concluding survey but also, and that with great emphasis, for all you have contributed to the development of engineering science.

Ladies and Gentlemen,

Allow me to speak a few words in the name of the Committee on Organization, before closing these Conferences.

When, more than a year and a half ago, it was decided to call these two scientific Congresses in Holland, our Committee gladly accepted their organization.

Although we well knew that our task would not be easy, we had no idea, at the beginning, that it would involve so much thought and labour. Had it not been for a great number of special commissions and many other devoted and indefatigable cooperators, our task would not have been brought to an end.

Our Committee thanks all those who have, by their continuous assistance, by their abil-

ities and their devotion, contributed to the success of the Congresses. It is impossible to name them all, but I think I must make an exception for the members of the Editorial Committee and their staff. The immense number of reports has made their task heavy, the more so as several reports did not conform with the requirements of the printers or arrived much later than was stipulated. Their work has not yet ended; they will be engaged a long time still in preparing the last volumes of the Proceedings of the Congress. As these Proceedings contain much that will keep its value for a long period, I think the profession is much indebted to them.

The Committee on Organization has fulfilled its task with the utmost pleasure. This was to a great extent due to the fact that we experienced a most cordial cooperation with the Presidents and Secretaries of both Permanent Committees in solving our many difficulties. The same acknowledgement extends to the National Committees and several individual members.

The Committee on Organization highly appreciates having had an opportunity to meet with so many colleagues, until recently only known by their correspondence or their scientific publications. In these few days we have made many friends, who will remain unforgettable to us, not only on account of their knowledge but perhaps still more on account of their personality.

And now the time has come to close the scientific part of the Conferences. I know that I am speaking on behalf of all my compatriots present, when, having thanked you again for your presence in this country, I wish you a good journey home and express the hope that we may meet again at the next Congress.

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ADDRESS AT THE FAREWELL DINNER

Prof. K. TERZAGHI

This is our last official gathering after a series of stimulating sessions covering every part of our common interests. These sessions gave us again an opportunity to realize how urgently our activities call for international cooperation, but probably few among you realize it as keenly as I do, on account of the unusually international character of my professional career.

During the last decades it has been my privilege to cooperate with members of no less than sixteen of the national groups assembled at this Conference, within the boundaries of their domains, and to become familiar with their problems. It was in Turkey where I had the first opportunity to apply some of the fundamental principles of soil mechanics to the solution of foundation problems. In the Balkans I experienced the practical implications of the hydrology of limestone terranes; on the Pacific Coast of the U.S.A. I became acquainted with the peculiar characteristics of sedimentary deposits in drowned valleys; in Alaska, with the engineering problems arising from permafrost conditions; in Costa Rica and in Brazil, with the treacherous character of deeply weathered rock, and in North Africa, with the difficulties of dam construction on semi-consolidated Tertiary deposits.

What impressed me more than anything else during these professional activities in the four corners of the globe was the extraordinary variety of subsoil and working conditions to which the engineer is compelled to adapt himself. Almost every important case called for improvisations and taxed to the utmost the resourcefulness of everybody involved.

While I served my apprenticeship, forty years ago, design and construction procedures were chiefly based on the experience accumulated by the older generations. However, during the subsequent decades, on account of the accelerated rate of industrial developments, the size and the scope of earthwork operation increased far beyond the boundaries of past experience. As a consequence, the risk of catastrophic failures also increased and a radical revision of the fundamental concepts of earthwork engineering became imperative. This situation led a quarter of a century ago to the advent of soil mechanics.

As the years went by, soil mechanics spread from the original centers of research over broader and broader areas. In one country

after another small groups of progressive engineers started to apply the fundamental principles of the new discipline to their own problems and provided us, in exchange for what they received, with new information which we could not have obtained in any other way. These national groups crystallized quite into an international community at work, each member striving to solve its own problems and, at the same time, stimulating and benefiting all the other members.

In 1936, under the auspices of Harvard University in Cambridge, Mass., the members of the soil mechanics community met for the first time and decided to establish an international organization. The spirit of cooperation in this small but very active organization has survived one of the most distressing periods in modern times. That is an inspiring fact. We do not have the power and the means to influence the pitiless trends of history. But let us cherish the thought that we have created, in our humble way, a small-scale image of what the Society of Nations could be, if the political relations between its members were governed by reason and good will and not by distrust, greed and lust for power.

We part with the conviction that the spirit of our organization will last, regardless of what the future may bring. We also part with a feeling of gratitude toward our hosts which words can hardly express. In spite of the cruel hardships which they and their compatriots have heroically endured during the last decade, they sacrificed month after month all their personal interests to make this conference a success; and the results of their efforts exceeded our most optimistic expectations. This conference certainly deserves a place of honor among all the engineering congresses of our days.

In addition to the marvels which the organizing committee has performed in the line of coordinating our professional activities, it prepared for us a reception which touched our hearts and which will never fade from our memories.

I invite the members of this conference to join me in a toast to the health and happiness of the members of the organizing committee and their charming ladies who provided us generously with the sunshine which the weather god of Holland has consistently withheld.

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