

INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING



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PROCEEDINGS
OF THE
INTERNATIONAL CONFERENCE
ON
SOIL MECHANICS AND
FOUNDATION ENGINEERING
JUNE 22 to 26, 1936



VOLUME I

GRADUATE SCHOOL OF ENGINEERING
HARVARD UNIVERSITY
CAMBRIDGE, MASS.

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SECOND PRINTING

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BOSTON, MASSACHUSETTS, U.S.A.

FOREWORD

General Remarks. The unexpectedly large number of contributions to the Conference and the fact that the majority of authors, particularly of some of the most valuable papers, have partially disregarded one or the other of the conditions for contributions to the Conference, have made the work of the Editorial Board very difficult. Since the majority of papers arrived after April 15th, and this volume had to be ready by the middle of May (to make it possible for participating members from Europe to receive their copies before their departure), the resources of the Editorial Board and of its clerical staff have been taxed to the limit in preparing the volume for publication. The short time available made planograph reproduction the only possible method to use. The reader's indulgence is requested for mistakes that may have occurred. The Secretary of the Conference will greatly appreciate being informed of necessary corrections. All corrections will be included in the last volume of the Proceedings.

It was soon realized that it would be physically impossible to publish in so short a time all papers submitted. Therefore, it was decided to print about one third of the contributions in a second volume, which is to be ready just prior to the Conference. Volume II will contain the entire Section "A", which comprises all "Reports from Soil Mechanics Laboratories on Testing Apparatus, Technique of Testing and Investigations in Progress". In addition, Volume II will include contributions which were delayed in their arrival, and papers which so grossly conflicted with the conditions in regard to length or language requirements that it was necessary to request the authors to submit them in a revised form. Volume III, containing the Discussions and additional contributions of special merit, will not be printed before August of this year.

The order in which the papers are printed essentially coincides with the order of arrival. In some instances it was chosen for technical reasons to facilitate and speed up the preparation of this volume. Papers which represent contributions to more than one section, if submitted as one unit, are classified in that section to which the contribution seemed to add most. The last section contains chiefly papers which, for technical reasons, were not ready for printing at the time the respective sections were closed. In the editing of the papers only important mistakes in syntax or the use of words, which might lead to misunderstandings, were corrected.

Discussions. This volume will reach most of the Members sufficiently in advance of the Conference to permit study of the contributions and preparation of discussions. It is particularly desirable that Members, (and also non-members) who have not contributed papers to the Conference and who have had extensive experience in one or the other of the subjects covered by the Conference, participate in the discussions, either in oral or written form. Written discussions must reach the Secretary not later than August 1, of this year.

A brief introductory remark should clearly define the subject of the discussion. It should be stated whether additional information is furnished of a nature not yet presented in the contributions, whether the information supports and supplements material already presented, or whether the discussion contains information that contradicts statements contained in a paper. In the latter case all differences in the conditions, particularly as to the character of the soil, should be emphasized, to permit a reader to formulate his conclusions.

All discussions should be specific, presented in a concise style, and must not exceed 1200 words. It is requested that generalities (complimentary remarks or otherwise) be omitted.

Complete Papers have been submitted by only a limited number of authors. It is, at present, not possible to say which of the contributions, contained in this volume, will be available in a more detailed form. Authors were requested to send one copy each of their complete papers, in English, French or German, to the following addresses:

- 1) Professor F. Schaffernak, Technische Hochschule, Vienna, Austria
- 2) Mr. Aage Bretting, Chief Engineer, Christiani & Nielsen, 77 Raadhusplads, Copenhagen, Denmark
- 3) Mr. G. Tschebotareff, The Foundation Soils Research Laboratory, Egyptian University, Giza-Cairo, Egypt
- 4) Dr. Oscar Faber, President of Structural Engineers, 10 Upper Belgrave Str., London S.W.1, England
- 5) Mr. K. Langer, Laboratoire d'Etude du Sol et des Fondations, Ministère de l'Education Nationale, 12 Rue Brancion, Paris XV^e, France
- 6) Professor A. Agatz, Technische Hochschule, Berlin, Germany
- 7) Mr. Giovanni Rodio, Corso Venezia 14, Milano (3) Italy
- 8) Professor N. M. Gershevanoff, Soljanka, 1. "WJOS", Moscow, USSR
- 9)&10) Two copies should be sent to the Secretary of the Conference, U. S. A.

These addresses represent the centers from which the full papers may be borrowed. It is evident that such centers could not be established in every country. However, it is believed that their locations are conveniently chosen.

It is suggested that Members and Absentee Members of the Conference or other interested persons who wish to borrow such papers, should send their request to the nearest of the above addresses. It is urgently requested that these papers should not be kept longer than one week, so that as many as possible may have an opportunity to study them prior to the Conference. Their primary purpose is to stimulate the contribution of discussions. Arrangements will also be made to permit the loan of these papers to interested persons after the Conference.

Cost of Proceedings. In view of the fact that the printing costs for the entire three volumes will be more than double those estimated, the Committee on Organization has decided that the registration fee for Conference members applying after May 15, 1936 shall be ten dollars, and that this shall also be the price for sale of any sets of the Proceedings which may remain after all the members of, and contributors to, the Conference have been supplied. Contributors of papers to the Conference, who are not members thereof, may purchase one set of the Proceedings for five dollars but must pay ten dollars per set for all additional sets desired.

Reprints. Many requests for reprints have been received. On account of technical difficulties, particularly the large variation in number of reprints desired, they cannot be printed at the same time as the Proceedings, but will be ordered after the Conference. A notice will be sent to all contributors informing them of the cost of reprints.

Cambridge, Massachusetts
May 5, 1936

EDITORIAL BOARD

Arthur Casagrande
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T A B L E O F C O N T E N T S

Section B: EXPLORATION OF SOIL CONDITIONS AND SAMPLING OPERATIONS

	Page
✓ B-1 Exploration of Soil Conditions and Sampling Operations. Submitted by Laboratory of Soil Mechanics, Delft (Netherlands)	1-2
✓ B-2 Sampling and Testing Undisturbed Sands from Boreholes. J. P. van Bruggen (Netherlands)	3-6
✓ B-3 Short Description of a Field-Testing Method with Coneshaped Sounding Apparatus. P. Barentsen (Netherlands)	7-10
✓ B-4 Exploration of Soil Conditions and Sampling Operations. William S. Hanna (Egypt)	10-11
✓ B-5 Exploration of Soil Conditions and Sampling Operation. L. F. Cooling and D. B. Smith (England)	12
✓ B-6 An Improved Type of Soil Sampler for Exploration of Soil Conditions and Sampling Operations. Thomas E. Stanton (U.S.A.)	13-15
✓ B-7 Description of An Apparatus to Register Graphically the <u>Settlements</u> of a Plane Plate Resting upon a Subsoil and Charged with a Constant or Increasing Load. J. L. A. Cuperas (Netherlands)	16-22

Section C: REGIONAL SOIL STUDIES FOR ENGINEERING PURPOSES

✓ C-1 Regional Soil Studies for Engineering Purposes. William S. Hanna (Egypt)	23-24
C-2 Soil Survey of the Flushing Meadow Park Site, Long Island, New York. George L. Freeman (U.S.A.)	25-30
✓ C-3 Relation between the <u>Chemical</u> Composition and the Physical Characteristics of Some Hawaiian Soils. Carl B. Andrews (Hawaii)	30-32

Section D: SOIL PROPERTIES

✓ D-1 Comparison Between <u>Consolidation</u> , <u>Elastic</u> , and Other Soil Properties Established from Laboratory Tests and from Observations of Structures in <u>Egypt</u> . Gregory Tschobotareff (Egypt)	33-36
✓ D-2 The Shearing Resistance of Soils. L. F. Cooling, D. B. Smith (England)	37-41
✓ D-3 Report on the Investigation of the <u>Compressibility</u> of the Ground of the Hydro-Electric Power Plant Svir 3 and on the Application of the Test Results to the Computation of the <u>Settlements</u> . A. Frey Samsioe (Sweden)	41-47
✓ D-4 Improved Methods of <u>Consolidation Test</u> and of the Determination of <u>Capillary Pressure</u> in Soils. N. Gersevanoff (USSR)	47-50
✓ D-5 Long Duration Consolidation Tests. J. H. van der Burght (Netherlands)	51
✓ D-6 The <u>Chemical</u> Nature of Soils. K. Endell and U. Hoffmann (Germany)	51-54
✓ D-7 The Shearing Resistance of Saturated Soils and the Angle between the Planes of Shear. Karl v. Terzaghi (Austria)	54-56

Section E: STRESS DISTRIBUTION IN SOILS

✓ E-1 Relation between Observed Inequalities of <u>Settlement</u> of Buildings in <u>Egypt</u> and Theoretical Stress Distribution, Based on <u>Boussinesq Formulas</u> . Gregory Tschobotareff (Egypt)	57-61
✓ E-2 The <u>Stress Distribution</u> round a <u>Pile</u> . F. E. Relton (Egypt)	61-63
✓ E-3 <u>Tangential Stresses</u> under a Spread Foundation. D. P. Krynine (U.S.A.)	63-66

(Section E Continued)

	Page
✓ E-4 Determination of <u>Stresses</u> Within a Two Dimensional Elastic and Isotropic Earth Mass. D. P. Krynine (U.S.A.)	66-70
✓ E-5 Studies of <u>Soil Pressures</u> and Soil Deformations by Means of a Centrifuge. G. I. Pokrovsky and I. S. Fedorov (USSR)	70-70

Section F: SETTLEMENT OF STRUCTURES

✓ F-1 <u>Settlement</u> Observations of <u>Buildings</u> in <u>Egypt</u> . William S. Hanna and Gregory Tsohebotareff (Egypt)	71-77
✓ F-2 Movements of <u>Building</u> Footings Due to <u>Earthquake</u> Loads. Frederick J. Converse (U.S.A.)	77-80
✓ F-3 <u>Settlement</u> of Exhibits <u>Buildings</u> at the Texas Centennial Central Exposition. Raymond F. Dawson (U.S.A.)	80-85
✓ F-4 <u>Settlement</u> Records of the Mississippi River <u>Bridge</u> at New Orleans. William P. Kimball (U.S.A.)	85-92
✓ F-5 A Case of <u>Bridge Abutment</u> Movement. C. L. Nord (U.S.A.)	93-100
✓ F-6 A Case of <u>Settlement</u> of a <u>Bridge Pier</u> . D. P. Krynine and C. L. Nord (U.S.A.)	100-103
✓ F-7 Results of Long Duration Settlement Tests. A. S. Keverling Buisman (Netherlands)	103-105
✓ F-8 Measuring <u>Groundwater</u> Pressures in a Layer of <u>Peat</u> Caused by an Imposed Load. J. C. N. Ringeling (Netherlands)	106-111
F-9 Direct Measuring of Internal Water Pressures in Clay. C. Biemond (Netherlands)	111-115
✓ F-10 <u>Settlement</u> of the Soil Surface around the <u>Foundation Pit</u> during the Construction of the <u>Locks</u> at Vreeswijk Resultant on the <u>Sinking</u> of the <u>Groundwater</u> . W. H. Brinkhorst (Netherlands)	115-119
✓ F-11 The National Theatre <u>Building</u> and Efforts made to Prevent its Further <u>Sinking</u> . José G. Ledesma (Mexico)	119-123

Section G: STABILITY OF EARTH AND FOUNDATION WORKS AND OF NATURAL SLOPES

✓ G-1 On Bank Slides in the Whangpoo River. Wang Yen (China)	124-133
✓ G-2 The Control of Landslides. Robert G. Hemes (U.S.A.)	133-135
✓ G-3 Foundation Investigation of Fort Peck <u>Dam</u> Closure Section. T. A. Middlebrooks (U.S.A.)	135-145
G-4 Uplift Pressure on Weirs of Simple and Complex Designs. E. McKenzie Taylor and V. J. Vaidhianathan. (India)	146-149
✓ G-5 Determination of <u>Groundwater</u> Tensions: A Necessary Element in Investigating the Stability of Slopes. G. H. van Mourik Broekman and A. S. Keverling Buisman (Netherlands)	150-156
✓ G-6 Critical Height and Factor of Safety of Slopes Against Sliding. Karl v. Terzaghi (Austria)	156-161
✓ G-7 Stability of Slopes of Natural Clay. Karl v. Terzaghi (Austria)	161-165

Section H: BEARING CAPACITY OF PILES

✓ H-1 Theory of Lateral Bearing Capacity of <u>Piles</u> . Paul E. Raes (Belgium)	166-169
✓ H-2 On the Computation of <u>Piles</u> Based on the Theory of Axial Impact. A. A. Kanschin and A. A. Plutalov (USSR)	169-173

(Section H Continued)

	Page
✓ H-3 The Carrying Capacity of <u>Piles</u> as Computed from Pile Loading and Pulling Tests. C. Franx (Netherlands)	173-180
 <u>Section I: PILE LOADING TESTS</u>	
✓ I-1 The Predetermination of the Required Length and the Prediction of the Toe Resistance of <u>Piles</u> . Submitted by Laboratory of Soil Mechanics, Delft (Netherlands)	181-184
✓ I-2 <u>Pile Loading Tests</u> at Zwijndrecht, Holland. G. C. Boonstra (Netherlands)	185-194
✓ I-3 Records of Some <u>Pile</u> Tests in Shanghai. S. E. Faber (China)	194-199
 <u>Section J: EARTH PRESSURE AGAINST RETAINING WALLS, EXCAVATION SHEETING, TUNNEL LININGS, ETC.</u>	
✓ J-1 The Distribution of Normal <u>Pressure</u> on a <u>Retaining Wall</u> Due to a Concentrated Surface Load. M. G. Spangler (U.S.A.)	200-207
✓ J-2 The Correlation of Soil Mechanics Studies with the Design and Construction of <u>Retaining Walls</u> . Robert F. Legget (Canada)	207-211
✓ J-3 Distribution of the Lateral Pressure of Sand on the Timbering of <u>Cuts</u> . Karl v. Terzaghi (Austria)	211-215
✓ J-4 Effect of the Type of Drainage of <u>Retaining Walls</u> on the Earth Pressure. Karl v. Terzaghi (Austria)	215-218
✓ J-5 A Fundamental Fallacy in <u>Earth Pressure</u> Computations. Karl v. Terzaghi Journal of the Boston Society of Civil Engineers, Vol. XXIII, No. 2, April, 1936.	328-336
 <u>Section K: GROUNDWATER MOVEMENT AND SEEPAGE</u>	
✓ K-1 Electric Investigation of <u>Underground Water Flow Nets</u> . C. G. J. Vreedenburgh and O. Stevens (Netherlands Indies)	219-222
✓ K-2 On the Steady Flow of <u>Water</u> Percolating through Soils with Homogeneous-anisotropic Permeability. C. G. J. Vreedenburgh (Netherlands Indies)	222-225
✓ K-3 <u>Seepage</u> under an Earth Dam. Submitted by Laboratoires du Batiments et des Travaux Publics, Ministere de L'Education Nationale, Paris (France)	225-227
✓ K-4 The Law of Distribution of Moisture in Soils and Methods for the Study of the Same. N. A. Ostashev (USSR)	227-228
 <u>Section L: SOIL PROBLEMS IN HIGHWAY ENGINEERING INCLUDING FROST ACTION IN SOILS</u>	
✓ L-1 Studies of Fill Construction Over Mud Flats Including a Description of Experimental <u>Construction</u> Using Vertical <u>Sand Drains</u> to Hasten Stabilization. O.J. Porter (U.S.A.)	229-235
✓ L-2 Experimental <u>Road</u> for Heavy Traffic on a very Compressible Soil (Peat-Bog-Ground). J. A. Royer (Netherlands)	235-238
✓ L-3 Vertical and Lateral Displacements of a Reinforced Concrete <u>Culvert</u> Under a High Earth Embankment. M. G. Spangler (U.S.A.)	238-243
✓ L-4 The Application of Soil Mechanics to <u>Highway</u> Foundation Engineering. John O. Morton (U.S.A.)	243-247
✓ L-5 Soil Profile Field Methods in New Hampshire. John O. Morton (U.S.A.)	247-247
✓ L-6 The Soil Survey as used by the Michigan State Highway Department. Olaf Stokstad (U.S.A.)	248-262

Section M: METHODS FOR IMPROVING THE PHYSICAL PROPERTIES OF SOILS FOR ENGINEERING PURPOSES, INCLUDING RECENT DEVELOPMENTS IN CONSTRUCTING AND COMPACTING EARTH FILLS

		Page
✓ M-1	A New Method of Impermeabilizing and Improving the Physical Properties of Pervious Subsoils by Injecting <u>Bituminous Emulsions</u> . J. Ph. Pfeiffer (Netherlands)	263-266
✓ M-2	Earth <u>Embankments</u> for the Pickwick Landing Dam. C. M. Weston (U.S.A.)	266-273
✓ M-3	Electrochemical Hardening of Clay Soils. K. Endell and U. Hoffmann (Germany)	273-275

Section N: MODERN METHODS OF DESIGN AND CONSTRUCTION OF FOUNDATIONS

✓ N-1	Foundation for the Palace of the Soviets: Designing a rigid Heavy Foundation on Compressible Materials through the Use of Soil Mechanics. Carlton S. Proctor (U.S.A.)	276-278
✓ N-2	Foundations of the New Telephone Building, Albany, New York. George W. Glick (U.S.A.)	278-284
✓ N-3	Some Features in Connection with the Foundation of Svir 3 Hydro-Electric Power Development. Prof. H. Graftio, Leningrad, in collaboration with Vattenbyggnadsbyran, VBB, Stockholm (Sweden)	284-290
✓ N-4	A Special Foundation Method for <u>Bridge Piers</u> , Adopted in Danish fjords. Prof. Anker Englund (Denmark)	291-294
✓ N-5	The Floating Foundation of the New Building for the National Lottery of Mexico: An Actual Size Study of the Deformations of a Flocculent-structured deep Soil by José A. Cuevas (Mexico)	294-301

Section Z: MISCELLANEOUS

✓ Z-1	Soil Mechanics as a Practical Science. William P. Kimball (U.S.A.)	302-306
✓ Z-2	Note on the Physical Characteristics of Mud from the Entrance Bar of the Yangtze River. Herbert Chatley (China)	306-307
✓ Z-3	<u>Stress Distribution</u> in Dry and in Saturated Sand Above a Yielding Trap-Door. Karl v. Terzaghi (Austria)	307-311
✓ Z-4	Investigation of the Bearing-Power of the Subsoil (Especially <u>Moraine</u>) with 25 x 25 mm Pointed Drill Weighted with 100 kg without Samples. O. Godskesen (Denmark)	311-314
✓ Z-5	Soil Studies for the Storstrom <u>Bridge</u> , Denmark. A. E. Bretting (Denmark)	314-327

A U T H O R I N D E X

✓ Andrews	C-3	✓ Freeman	C-2	✓ Proctor	N-1
✓ Barentsen	B-3	✓ Gersevanoff	D-4	✓ Raes	H-1
✓ Biemond	F-9	✓ Glick	N-2	✓ Relton	E-2
✓ Boonstra	I-2	✓ Graftio	N-3	✓ Ringeling	F-8
✓ Bretting	Z-5	✓ Hanna	B-4, C-1, F-1	✓ Royer	L-2
✓ Brinkhorst	F-10	✓ Hennes	G-2	✓ Samsioe	D-3
✓ Broekman	G-5	✓ Hoffmann	D-6, M-3	✓ Smith	B-5, D-2
✓ van Bruggen	B-2	✓ Kanschin	H-2	✓ Spangler	J-1, L-3
✓ Buisman	F-7, G-5	✓ Kimball	F-4, Z-1	✓ Stanton	B-6
✓ van der Brught	D-5	✓ Krynine	E-3, E-4, F-6	✓ Stevens	K-1
✓ Chatley	Z-2	✓ Ledesma	F-11	✓ Stokstad	L-6
✓ Converse	F-2	✓ Legget	J-2	✓ Taylor	G-4
✓ Cooling	B-5, D-2	✓ Middlebrooks	G-3	✓ Terzaghi	D-7, G-6, G-7
✓ Cuevas	N-5	✓ Morton	L-4, L-5		J-3, J-4, J-5
✓ Cuperas	B-7	✓ Nord	F-5, F-6		Z-3
✓ Dawson	F-3	✓ Ostashev	K-4	✓ Tschebotareff	D-1, E-1, F-1
✓ Endell	D-6, M-3	✓ Pfeiffer	M-1	✓ Vaidhianathan	G-4
✓ Englund	N-4	✓ Plutalow	H-2	✓ Vattenbyggnadsbyran	N-3
✓ Faber	I-3	✓ Pokrovsky	E-5	✓ Vreedenburgh	K-1, K-2
✓ Fedorov	E-5	✓ Porter	L-1	✓ Wang Yen	G-1
✓ Franx	H-3			✓ Weston	M-2

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FOREWORD

General Information. In addition to the general remarks and the information on reprints contained in the Foreword of Volume I, the Editorial Board wishes to announce that a number of contributions submitted in languages other than English could not be accepted for publication. The only exceptions were descriptions of Soil Mechanics Laboratories. For these reports the rule that all contributions must be in English was disregarded, in order to permit the presentation of as complete a record as possible on the existing Soil Mechanics Laboratories. From several laboratories no reports were submitted and therefore such laboratories are not represented in this volume.

Since a number of contributions to Section "A" followed the outline suggested in the original printed information for contributors, the outline is repeated here to acquaint the readers with the arrangement of many of these reports.

REPORTS FROM SOIL MECHANICS LABORATORIES ON TESTING APPARATUS,
TECHNIQUE OF TESTING AND INVESTIGATIONS IN PROGRESS

1. Name of institution, organization or firm supporting the laboratory; its location and year established.
2. Name and title of person in charge of laboratory; number of persons on regular staff and average number of temporary employees or students engaged in research.
3. Principal purpose for which laboratory is equipped (research, instruction or consulting service).
4. Description of equipment:
 - (a) Total floor area, deducting office space. Humid room and constant temperature room; type of equipment for humidification and temperature control.
 - (b) Apparatus for the classification of soils according to grain size distribution, grain shape, porosity, relative density, water content, air content, lime content, content of organic matter, specific gravity of mineral matter, Atterberg limit tests, consistency.
 - (c) Apparatus for shearing tests.
 - (d) Apparatus for compressive strength tests.
 - (e) Apparatus for consolidation tests.
 - (f) Apparatus for permeability tests, for the determination of capillary rise and of maximum capillary pressure.
 - (g) Apparatus for investigation of frost action.
 - (h) Apparatus for earth pressure investigations.
 - (i) Apparatus for special investigations.

5. Soil Testing Procedures:

- (a) Tools and procedures for taking undisturbed samples. Dimensions of samples. (To be omitted if separate report is submitted for division "Exploration of Soil Conditions and Sampling Operations.")
- (b) Field testing methods. Loading tests, usual size of loaded area; loading tests in holes; vibration methods; etc.
- (c) Laboratory testing methods for tests outlined in (4).

Note: For points (4) and (5) give references to publications describing apparatus and procedures. If such references are not available, give short description, including drawings. Always state dimensions of soil samples used.

6. Short description of the most important types of soils in the working region of the laboratory, including geological name, natural water content, Atterberg limits, compressive strength in the undisturbed and remolded states, etc. (To be omitted if separate report is submitted for division "Regional Soil Studies for Engineering Purposes.")
7. Short statement of the subjects of scientific investigations. When performed? Where published? If still in progress, approximate date when investigation will be finished with brief statement of most important results found so far.
8. Short statement of the most important practical investigations. Subject, types of soils encountered, most important results.
9. Observations on existing structures under the direction of the laboratory. Customary number of observation points, type of observation points on the structure and in the ground, methods for surveying the points. Type and number of observed structures.
10. Experience regarding the difference between predicted and observed behavior of structures. Empirical rules which were derived from such studies.

Complete Papers. Among the contributions contained in Volumes I and II of the Proceedings, the following twenty papers have been submitted in a more complete form. Copies of these papers have been sent to the addresses listed in the Foreword of Volume I, and may be borrowed by any one interested in them.

PAPER NO.

AUTHOR AND TITLE

A-6	Housel, W. S., Report from Soil Mechanics Laboratory, University of Michigan
A-8	Hartman, J. P., Report of Soils Testing Laboratory, U.S. Engineer Office, Fort Peck, Montana
A-24	Report from the Soil Mechanics Laboratory at the Technische Hochschule in Vienna, Austria
C-2	Freeman, G. L., Soil Survey of the Flushing Meadow Park Site, Long Island, New York
D-10	Buisson, M., Shearing Tests. Compressive Tests on Cylinders. Comparison of Results in View of Determining the Angle of Friction and the Settlements in Soils
D-11	Hvorslev, M. J., A Ring Shearing Apparatus for the Determination of the Shearing Resistance and Plastic Flow of Soils
E-2	Reiton, F. E., The Stress Distribution Around a Pile
F-2	Converse, F. J., Movements of Building Footings due to Lateral Loads on the Superstructure
F-4	Kimball, W. P., Settlement Records of the Mississippi River Bridge at New Orleans
F-9	Biamond, C., Direct Measuring of Internal Water Pressures in Clay
G-2	Hennes, R. G., The Control of Landslides
G-3	Middlebrooks, T. A., Foundation Investigation of Fort Peck Dam Closure Section
H-2	Kanschin, A. A., and Flutalov, A. S., On the Computation of Piles Based on the Theory of Axial Impact
J-1	Spangler, M. G., The Distribution of Normal Pressure on a Retaining Wall due to a Concentrated Surface Load
J-2	Legget, R. F., The Correlation of Soils Mechanics Studies with the Design and Construction of Retaining Walls
K-3	Mayer, A., and Mandel, Seepage Under an Earth Dam
L-3	Spangler, M. G., Vertical and Lateral Displacements of a Reinforced Concrete Culvert under a High Earth Embankment
L-6	Stokstad, O. L., The Soil Survey as Used by the Michigan State Highway Department
M-1	Pfeiffer, J. P., A New Method of Impermeabilizing and Improving the Physical Properties of Pervious Subsoils by Injecting Bituminous Emulsions
Z-1	Kimball, W. P., Soil Mechanics as a Practical Science

Discussions. It is hoped that experienced engineers (including non-members) who have not yet contributed papers to the Conference, and who are in possession of additional valuable information on the many subjects covered by the contributions to the Conference, will make them available in form of written discussions, to be published in Volume III of the Proceedings.

Written discussions must reach the Secretary not later than August 15, 1936, should be presented in a concise style, and should not exceed 1200 words in length. No restriction is placed on the number of necessary tables and figures. It is requested that generalities (complimentary remarks or otherwise) be omitted. A brief introductory statement should clearly define the subject of the discussion. It should be stated whether additional information is furnished of a nature not yet presented in the contributions, whether the information is intended to support or supplement material already presented in the Proceedings, or whether the discussion contains information that contradicts statements contained in one or several contributions. In the latter case all differences in the conditions, particularly as to the character of the soil, should be emphasized to permit the reader to formulate his conclusions.

Volume III will be ready for distribution in September 1936.

Cambridge, Massachusetts
June 12, 1936

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TABLE OF CONTENTS

Section A: REPORTS FROM SOIL MECHANICS LABORATORIES ON TESTING APPARATUS,
TECHNIQUE OF TESTING AND INVESTIGATIONS IN PROGRESS

	Page
A-1 General Report from the Laboratory of the Egyptian University in Cairo. Charles Andreas. (Egypt).	1-3
A-2 Report on Testing Apparatus, Technique of Testing and Investigations in Progress. Submitted by the Laboratory of Soil Mechanics, Delft (Holland).	3-12
A-3 Report from Soil Mechanics Laboratory on Testing Apparatus, Technique of Testing, and Investigations in Progress. Submitted by Building Research Station, Garston, Herts (England).	12-16
A-4 Report on an Apparatus for Consummate Investigation of the Mechanical Properties of Soils. Walter Kjellman. (Sweden).	16-20
A-5 The Soil Mechanics Laboratory at Yale University. D. P. Kryzine. (U.S.A.).	20-24
A-6 Report from the Soil Mechanics Laboratory at the University of Michigan on Testing Apparatus, Technique of Testing, and Investigations in Progress. W. S. Housel. (U.S.A.).	24-28
A-7 Cornell University Soil Mechanics Laboratory. H. T. Jenkins. (U.S.A.).	28-29
A-8 Report of Soils Testing Laboratory Fort Peck District, U. S. Engineer Office at Fort Peck, Montana. J. P. Hartman. (U.S.A.).	29-33
A-9 Report on the Laboratoire du Sol et des Fondations. Submitted by the Laboratoires du Batiment et des Travaux Publics, Ministere de l'Education Nationale, Paris (France).	34-36
A-10 Apparatus for Testing Compressibility and <u>Capillary</u> Properties of Soils. V. Boulichev. (USSR).	37-38
A-11 The Spring-Scale Cone. A Pocket Apparatus for Determining the Firmness of Clay. O. Godskesen. (Denmark).	38-40
A-12 Recent Progress of Research Works on Soil Mechanics in Japan, especially about some Soil Mechanics Laboratories. N. Yamaguti. (Japan).	40-42
A-13 A New Method for Determining the Relative <u>Consistency</u> of Soils. Donald M. Burmister. (U.S.A.).	43-47
A-14 Soil Engineering in the Tennessee Valley. Evan W. Vaughan. (U.S.A.).	48-49
A-15 Report on Work of the American Society for Testing Materials. C. A. Hogentogler and W. S. Housel. (U.S.A.).	49-52
A-16 Soil Mechanics Laboratory at the Thayer School of Civil Engineering. W. P. Kimball. (U.S.A.).	52-54
A-17 The Soil Mechanics Division of the Preussische Versuchsanstalt für Wasserbau and Schiffbau in Berlin. (Germany).	55-56
A-18 The Soil Mechanics Laboratory at the Mining Academy of Freiberg. (Germany).	56-58
A-19 The Soils Laboratory of the Division of Tests, U. S. Bureau of Public Roads. (U.S.A.).	58-62
A-20 The Division for Soil Mechanics of the Franzius-Institute for Foundations and Hydraulics at the Technical University in Hanover. (Germany).	62-66
A-21 Determination of the Water Content of Soil Samples by Means of Xylol. Begemann. (✓ Germany).	66-67
A-22 The Institute of the German Research Society for Soil Mechanics (Degebo) at the Technische Hochschule in Berlin. (Germany).	68-72
A-23 The Soil Mechanics Laboratory of the U. S. Waterways Experiment Station, Vicksburg, Mississippi. S. J. Buchanan. (U.S.A.).	72-81
A-24 The Soil Mechanics Laboratory at the Technische Hochschule in Vienna. (Austria).	81-85
A-25 The Soil Mechanics Laboratory at Harvard University. P. C. Rutledge. (U.S.A.).	85-97

Section B: EXPLORATION OF SOIL CONDITIONS AND SAMPLING OPERATIONS

	Page
B-8 Preliminary Results of <u>Coring</u> in Loose Strata. H. Fehlmann. (Switzerland).	98-101

Section C: REGIONAL SOIL STUDIES FOR ENGINEERING PURPOSES

C-4 Bibliography of Shanghai Soils and Foundations. Submitted by Engineering Society of China.	102
C-5 Testing the Subsoil for the New Drinking Water Reservoir of the City of Vienna at the Lainz Game Preserve. R. Tillmann. (Austria).	102-107
C-6 Regional Soil Study of Clays from Chicago, Illinois. P. C. Rutledge. (U.S.A.).	107-111

Section D: SOIL PROPERTIES

D-8 On the Influence of Scale-like Shape of Clay Particles on the Process of Shear in Soils. George Ter-Stepanian. (USSR).	112-116
D-9 The Influence of the Speed of Loading Increment on the Pressure Void Ratio Diagram of Undisturbed Soil Samples. Karl Langer. (France).	116-120
D-10 <u>Shearing Tests</u> , Compressive Tests on Cylinders. Comparison of Results in View of Determining the Angle of Friction and the Settlements in Soils. Maurice Buisson. (France).	121-125
D-11 A Ring <u>Shearing Apparatus</u> for the Determination of the Shearing Resistance and Plastic Flow of Soils. M. Juul Hvorslev. (Austria).	125-129
D-12 An Investigation of Jürgensen's Squeeze Test. Arpad Warlam. (Hungary).	129-133
D-13 Progress Report on an Investigation of the <u>Shearing Resistance</u> of Cohesionless Soils. J. D. Parsons. (U.S.A.).	133-138
D-14 Progress Report on Research on the Consolidation of Fine-Grained Soils. Hamilton Gray. (U.S.A.).	138-141

Section E: STRESS DISTRIBUTION IN SOILS

E-6 A Rational Method for the Determination of the Vertical Normal <u>Stresses</u> under Foundations. W. Steinbrenner. (Austria).	142-143
E-7 A Method of Representing the <u>Distribution of Stress</u> in Ground. Charles Fischer. (Austria).	144
E-8 Influence of Rigidity of a Circular Foundation Slab on the <u>Distribution of Pressures</u> over the Contact Surface. Hubert Borowicka. (Austria).	144-149
E-9 The Measurement of <u>Soil Pressures</u> on the Lining of the Midtown Hudson Tunnel. G. M. Rapp and A. H. Baker. (U.S.A.).	150-156
E-10 <u>Stress Distribution</u> in Elastic Solids. Hamilton Gray. (U.S.A.).	157-168
E-11 Correlation of Surface Loading Tests with <u>Unconfined Compression Tests</u> for Cohesive Soils. Austin B. Mason. (U.S.A.).	169-173

Section F: SETTLEMENT OF STRUCTURES

F-12 Settlement Records and Loading Data for Various Buildings Erected by the Public Works Department, Municipal Council, Shanghai. N. W. B. Clarke and J. B. Watson. (China).	174-185
F-13 Foundation Data. J. A. Favret. (China).	185-186
F-14 Foundation Soil Testing and Settlement Measuring. Charles Fischer. (Austria).	186-191
F-15 Securing a Vienna Tenement House against Injurious Settlement by Reducing the Soil Pressure and <u>Draining</u> the Underground. R. Tillmann. (Austria).	191-193

Section G: STABILITY OF EARTH AND FOUNDATION WORKS AND OF NATURAL SLOPES

G-8 On the Stability of Foundations of <u>Embankments</u> . Leo Jürgenson. (Estonia).	194-200
G-9 Stability of Earth Slopes. Joseph Jáky. (Hungary).	200-207

<u>Section H: BEARING CAPACITY OF PILES</u>		Page
H-4	Conditions for the Stability of Piles. B. M. Lozovsky. (USSR).	208-211
H-5	Dynamic Formula for Determining the Resistance of Piles. B. M. Lozovsky. (USSR).	212-216
H-6	Notes on the <u>File Driving</u> Formula Included in the Proposed Boston Building Code. J. Stuart Crandall. (U.S.A.).	216-220
 <u>Section I: PILE LOADING TESTS</u>		
I-4	<u>File Driving</u> and <u>Test-loading</u> Records. N. W. B. Clarke and J. B. Watson. (China).	221-227
I-5	<u>Load Test</u> on a Wood Pile Driven into the Ground. R. Tillmann. (Austria).	227-229
I-6	<u>File Loading Tests</u> , Bonnet Carre Floodway. J. P. Dean and J. C. Baehr. (U.S.A.).	229-253
 <u>Section J: EARTH PRESSURE AGAINST RETAINING WALLS, EXCAVATION SHEETING, TUNNEL LININGS, ETC.</u>		
J-6	Relation between <u>Relative Density</u> and <u>Earth Pressure</u> . Hans Petermann. (Germany).	254-255
 <u>Section L: SOIL PROBLEMS IN HIGHWAY ENGINEERING INCLUDING FROST ACTION IN SOILS</u>		
L-7	Observations of the Texas State Highway Department on the Subsequent Effects of the Uniformity and the Non-Uniformity of Foundation Soil-Types on Pavements; and also the Effects of Uniformity and Non-Uniformity of Moisture Content Fluctuations in Soil Foundations of High Volumetric Change. Henry C. Porter. (U.S.A.).	256-260
L-8	Progress Report on an Investigation of <u>Frost</u> Action in Soils. A. Mackintosh. (U.S.A.).	260-262
 <u>Section M: METHODS FOR IMPROVING THE PHYSICAL PROPERTIES OF SOILS FOR ENGINEERING PURPOSES, INCLUDING RECENT DEVELOPMENTS IN CONSTRUCTING AND COMPACTING EARTH FILLS</u>		
M-4	Soil Consolidation Works Effected near Elne, France on a <u>Bridge</u> over the Tech River. P. Bachy. (France).	263
 <u>Section N: MODERN METHODS OF DESIGN AND CONSTRUCTION OF FOUNDATIONS</u>		
N-6	The Failure of <u>Bridge Piers</u> due to Scour. Karl v. Terzaghi. (Austria).	264
N-7	Concrete Filled Steel Cylinders for Foundations. Harry T. Immerman. (U.S.A.).	264-267
N-8	Foundations of 40 Wall St., New York City. Harry T. Immerman. (U.S.A.).	267-272
N-9	<u>Cofferdams</u> . Lazarus White. (U.S.A.).	272-279
 <u>Section Z: MISCELLANEOUS</u>		
Z-6	Principles Governing Interpretation of Results Obtained Through Exploration of Soils for Foundation Purposes. J. M. Abeleff. (USSR).	280-282
Z-7	About the Protection of Structures from the Existence of Radiating Elastic Waves in the Soil. D. D. Barkan. (USSR).	283-284
Z-8	Field Investigations of the Theory of Vibration of Massive <u>Foundation</u> under <u>Machines</u> . D. D. Barkan. (USSR).	285-288
Z-9	A Method of Determining the Rate of Deformation in Soil Mass by Means of <u>Electricity</u> . G. I. Pokrowski. (USSR).	289-290
Z-10	Consolidation of <u>Marine Clay</u> . O. K. Froehlich (Austria).	290-294
Z-11	Pretest Shoring of Retaining Wall. Harry T. Immerman. (U.S.A.).	294-296
Z-12	The Alexander <u>Dam</u> . Soil Studies and Settlement Observations. Joel B. Cox. (U.S.A.).	296-298
Z-13	Experiments with Models for Determining the Deformation and Tensions in Foundations on Plastic Ground. Ad. Pogány. (Poland).	298-299

Z-14	Water Supply Sources for Metropolitan Boston, Frank E. Winsor. (U.S.A.).	Page 300
Z-15	Foundations and Embankments of Queabbin Dams. Stanley M. Dore. (U.S.A.).	300-307
Z-16	Soil Mechanics Laboratory at the Technical University of Budapest, Hungary. Joseph Jaky. (Hungary).	307
Z-17	Proposed New Boston Building Code - Chapter on Foundations. Gilbert Small. (U.S.A.).	308-318
Z-18	Practical Soil Mechanics at Muskingum. Theodore T. Knappen and Robert R. Phillipe. (U.S.A.).	Appendix (reprint)
Z-19	Improved Soil Testing Methods. Glennon Gilboy. (U.S.A.).	Appendix (reprint)
Z-20	Simple Tests Determine Hydrostatic Uplift. Karl v. Terzaghi. (Austria).	Appendix (reprint)
Z-21	Field Test for Identification of Soils Capable of Frost Heaving. Leo Jürgenson. (Estonia).	Appendix (reprint)

A U T H O R I N D E X

Abeleff	Z-6	Froehlich	Z-10	Parsons	D-13
Andreae	A-1	Gilboy	Z-19	Petermann	J-6
✓ Bachy	M-4	Gedskesen	A-11	Phillipe	Z-18
✓ Baehr	I-6	Gray	D-14, E-10	Pogany	Z-13
✓ Baker	E-9	Hartman	A-8	Pokrowski	Z-9
✓ Barkan	Z-8, Z-9	Hogentogler	A-15	Porter	L-7
✓ Begemann	A-21	Housel	A-6, A-15	Rapp	E-9
✓ Borowicka	E-8	Hvorslev	D-11	Rutledge	A-25, C-6
✓ Boulichev	A-10	Immerman	N-7, N-8, Z-11	Small	Z-17
✓ Buchanan	A-23	Jaky	G-9, Z-16	Steinbrenner	E-6
✓ Buisson	D-10	Jenkins	A-7	Ter-Stepanian	D-8
✓ Burmister	A-13	Jürgenson	G-8, Z-21	Terzaghi	N-6, Z-20
Crandall	H-6	Kimball	A-16	Tillmann	C-5, F-15, I-5
Clarke	F-12, I-4	Kjellman	A-4	Vaughan	A-14
Cox	Z-12	Knappen	Z-18	Warlam	D-12
Dean	I-6	Krynine	A-5	Watson	F-12, I-4
Dore	Z-15	Langer	D-9	White	N-9
Favret	F-13	Lozovsky	H-4, H-5	Winsor	Z-14
Fehlmann	B-8	Mackintosh	L-8	Yamaguti	A-12
Fischer	E-7, F-14	Mason	E-11		

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TABLE OF CONTENTS

	Page
Secretary's Report. A. Casagrande (U.S.A.).	1-8
Treasurer's Report. P. C. Rutledge. (U.S.A.).	8-10
ADDRESSES	
Opening Remarks. A. Casagrande. (U.S.A.).	11
Address of Welcome. James B. Conant. (U.S.A.).	11-12
Relation Between Soil Mechanics and Foundation Engineering. Karl v. Terzaghi. (Austria).	13-18
Address. Daniel E. Moran. (U.S.A.).	18-19
Soil Study and Engineering. F. E. Sohmitt. (U.S.A.).	19-21
Farewell Address. A. Agatz. (Germany).	21-22
Closing Address of the President. Karl v. Terzaghi. (Austria).	22-23
 <u>Section B:</u> EXPLORATION OF SOIL CONDITIONS AND SAMPLING OPERATIONS	
B-9 Opening Discussion. Henry A. Mohr. (U.S.A.).	24
B-10 Discussion. Daniel E. Moran. (U.S.A.).	24-25
B-11 Discussion. Earl F. Bennett. (U.S.A.).	26
B-12 Discussion. A Method for Determining the Representative Character of Undisturbed Samples and Something of the Disturbance Caused by the Sampling Operation. Donald M. Burmister. (U.S.A.).	26-28
B-13 Discussion. Harold E. Russell. (U.S.A.).	29
B-14 Discussion. Spencer J. Buchanan. (U.S.A.).	29
B-15 Discussion. Evan W. Vaughan. (U.S.A.).	29-30
B-16 Comments on Various Papers. (B-3, B-6, B-7).	30
 <u>Section D:</u> SOIL PROPERTIES	
D-15 Opening Discussion. Donald W. Taylor. (U.S.A.).	31-33
D-16 Discussion. Soil Properties as Functions of General Soil Formation Processes. H. F. Winterkorn. (U.S.A.).	33
D-17 Discussion of Paper C-2. Interpretation of Some of the Results of the Soil Survey of the Flushing Meadows Park Site. Donald M. Burmister. (U.S.A.).	33-36
D-18 Discussion. William P. Kimball. (U.S.A.).	37
D-19 Discussion. G. Tsohebotareff. (Egypt).	37-38
D-20 Discussion. C. A. Hogentogler. (U.S.A.).	38-39
D-21 Discussion. George E. Ekblaw. (U.S.A.).	39
D-22 Discussion. L. F. Cooling. (England).	39-40

	Page
D-23 Discussion of Paper D-6 (By Letter). The Chemical Nature of Clays. H. F. Winterkorn. (U.S.A.)	40-42
D-24 Discussion (By Letter). Apparatus for Testing Soils in Compacted State. C. A. Hogentogler, Jr. (U.S.A.).	42-44
D-25 Discussion (By Letter). Permeability Device for Undisturbed Sand Samples. Joseph Szily. (Hungary).	44-46
D-26 Discussion (By Letter). New Apparatus for Volumetric Determination of Carbonates and Water Contents in Soils. Ladislav C. Smolik. (Czechoslovakia).	47-48
D-27 Discussion (By Letter). Relation Between Void Ratio and Effective Principal Stresses for a Remoulded, Silty Clay. Leo Rendulic. (Germany).	48-51
D-28 Discussion (By Letter). Conditions of Failure for Remoulded Cohesive Soils. M. Juul Hvorslev. (Austria).	51-53
D-29 Discussions (By Letter). Maurice Buisson. (France).	53-56
D-30 Discussions (By Letter). Carl B. Andrews. (Honolulu).	56-57
D-31 Discussion of Paper D-6 (By Letter). T. A. Middlebrooks. (U.S.A.).	57
D-32 Discussion. Lazarus White. (U.S.A.).	58
D-33 Discussion (By Letter). Notes on the Shearing Resistance and the Stability of Cohesionless Soils and their Relation to the Design of Earth Dams. Arthur Casagrande. (U.S.A.).	58-60
D-34 Discussion (By Letter). The Determination of the Pre-Consolidation Load and Its Practical Significance. Arthur Casagrande. (U.S.A.).	60-64
D-35 Comments on Various Papers. (D-1, C-6).	64
D-36 Discussion (By Letter). Bror Fellenius. (Sweden).	65

Section E: STRESS DISTRIBUTION IN SOILS

E-12 Opening Discussion. Pressure Distribution. Franz Kogler. (Germany).	66-70
E-13 Discussion on the Distribution of Stress around a Pile. Raymond D. Mindlin. (U.S.A.).	71
E-14 Discussion. A Graphical Method of Determining the Distribution of Stress in the Underground Due to Foundation Loads. Donald M. Burmister. (U.S.A.).	71-73
E-15 Discussion. D. P. Kryzine. (U.S.A.).	73-74
E-16 Discussion. Benjamin K. Hough, Jr. (U.S.A.).	75
E-17 Discussion (By Letter). Stress Distribution as a Problem in Attraction. George W. Glick. (U.S.A.).	76-77
E-18 Comments on Various Papers. (E-9).	77
E-19 Discussion (By Letter). Thomas A. Middlebrooks. (U.S.A.).	78
E-20 Discussion of Paper No. E-4 (By Letter). D. P. Kryzine. (U.S.A.)	78

Section F: SETTLEMENT OF STRUCTURES

F-16 Opening Discussion. Karl v. Terzaghi. (Austria).	79-87
F-17 Discussion. Interpretation of Loading Tests for Footings. Donald M. Burmister. (U.S.A.)	87-88

	Page
F-18 Discussion. Additional Experience on Situ-Cast Concrete Piles. Rudolf Tillman. (Austria).	89
F-19 Discussion of Paper F-2. Rudolf Tillman. (Austria).	89-90
F-20 Discussion. Wilhelm Loos. (Germany).	90-92
F-21 Discussion of Papers No. F-12 and F-13 (By Letter). On Settlement of Structures in Shanghai, China. Karl v. Terzaghi. (Austria).	92-96
F-22 Discussion on the Movements of the Piers of the Mississippi River Bridge, Paper No. F-4. Karl v. Terzaghi. (Austria). and William P. Kimball. (U.S.A.)	96-98
F-23 Discussion of Paper F-4 (By Letter). Settlement Records of the Mississippi River Bridge at New Orleans. William P. Kimball. (U.S.A.).	98-99
F-24 Discussion. William S. Housel. (U.S.A.).	99-101
F-25 Discussion on Paper No. F-8. (By Letter). Maurice Buisson. (France).	101
F-26 Discussion (By Letter). Soil Testing and Observation in the Design and Construction of Rotunden-Bridge Across the Danube River in Vienna. Charles Fischer. (Austria).	102-103
F-27 Discussion of Paper No. F-6 (By Letter). Thomas A. Middlebrooks. (U.S.A.).	103
F-28 Discussion (By Letter). Settlement Observations on Structures of the "Reichsautobahnen". Leo Casagrande. (Germany).	104-106
F-29 Discussion (By Letter). Comparison of Computed and Observed Settlements. Ernst von Gottstein. (Germany).	107-110
F-30 Comments on Various Papers (F-2, F-14).	110
 <u>Section G: STABILITY OF EARTH AND FOUNDATION WORKS AND OF NATURAL SLOPES</u>	
G-10 Opening Discussion. Frank A. Marston. (U.S.A.).	111-112
G-11 Opening Discussion. Stability of Embankment Foundations. G. Gilboy. (U.S.A.)	112
G-12 Discussion. T. T. Knappen. (U.S.A.).	112-113
G-13 Discussion. A Method for Determining the Shearing Resistance of Fill Materials, Earth Embankments, etc. in Place by Means of a New Shear Apparatus. Donald M. Burmister. (U.S.A.).	114-116
G-14 Discussion. Joachim Ehrenberg. (Germany).	117-118
G-15 Discussion on Gilboy's Presentation of Jurgenson's Method of Foundation Analysis. T. A. Middlebrooks. (U.S.A.).	118
G-16 Discussion. Notes on the Stability of Slopes. Donald W. Taylor. (U.S.A.).	118-122
G-17 Discussion (By Letter). Two Examples Concerning Underground Sliding Caused by Construction of Embankments and Static Investigations of the Effectiveness of Measures Provided to Assure their Stability. Ernst von Gottstein. (Germany).	122-128
G-18 Discussion of Paper No. G-3 (By Letter). Arshag G. Solakian. (U.S.A.)	128-129
G-19 Discussion (By Letter). Robert G. Hennes. (U.S.A.).	129
G-20 Comments on Various Papers. (G-1, G-2, G-3, G-4).	130

	Page
<u>Section H: BEARING CAPACITY OF PILES</u>	
H-7 Opening Discussion. J. S. Crandall. (U.S.A.).	131-132
H-8 Discussion on Sections H and I. John G. Mason. (U.S.A.).	132-136
H-9 Discussion. R. Pietkowski. (Poland).	136-137
H-10 Discussion. Lazarus White. (U.S.A.).	137-138
H-11 Discussion on the Lateral Resistance of Piles, Paper No. H-1. Paul Raes (Belgium) and A. E. Cummings. (U.S.A.).	138-140
H-12 Discussion on Sections H and I. W. S. Hanna and Gregory Tschebotareff. (Egypt).	140-141
H-13 Discussion. Carlton S. Proctor. (U.S.A.).	141
H-14 Discussion. Kjetil Haugeto. (U.S.A.).	141-142
H-15 Discussion (By Letter). Some References to Pile Driving and the Supporting Power of Piles in British Technical Publications. Robert F. Leggett. (Canada).	142-143
H-16 Discussion of Paper No. H-5 (By Letter). Dimitri P. Krynine. (U.S.A.).	143-144
H-17 Discussion of Paper No. H-2 (By Letter). Calculation of Piles According to the Theory of the Longitudinal Flow. B. B. Kretschmer. (USSR).	144-145
H-18 Report on Special Meeting of the Committee on Bearing Value of Pile Foundations, Waterways Division, American Society of Civil Engineers.	145-151
H-19 Comments on Various Papers. (I-5).	151
<u>Section J: EARTH PRESSURE AGAINST RETAINING WALLS, EXCAVATION SHEETING, TUNNEL LININGS, ETC.</u>	
J-7 Opening Discussion. Arthur Casagrande. (U.S.A.)	152
J-8 Discussion. Karl v. Terzaghi. (Austria).	152-155
J-9 Discussion. Pressure Distributions on Retaining Walls. Raymond D. Mindlin. (U.S.A.)	155-156
J-10 Discussion of Paper J-3. Jeremiah E. B. Jennings. (U.S.A.).	157-158
J-11 Discussion of Paper No. J-1 (By Letter). A. E. Cummings. (U.S.A.).	158-159
J-12 Discussion of Paper No. J-1 (By Letter). D. P. Krynine. (U.S.A.).	159-160
J-13 Discussion (By Letter). Some References to Lateral Earth Pressure in British Technical Publications. Robert F. Leggett. (Canada).	160
<u>Section K: GROUND WATER MOVEMENT AND SEEPAGE</u>	
K-5 Opening Discussion. Joel D. Justin. (U.S.A.).	161
K-6 Discussion. William P. Creager. (U.S.A.).	161-162
K-7 Discussion. A Practical Application of the Flow Net Method of Analysis to the Design of Cofferdams. Donald M. Burmister. (U.S.A.).	162-164
K-8 Discussion of Paper K-3 (By Letter). Direct Measurement of the Permeability of the Ground. J. P. Daxelhofer. (France).	164-165
K-9 Discussion. O. Stevens. (Netherlands Indies).	165-166

	Page
<u>Section L:</u> SOIL PROBLEMS IN HIGHWAY ENGINEERING INCLUDING FROST ACTION IN SOILS	
L-9 Opening Discussion. Soils for Highway Uses. C. A. Hogentogler. (U.S.A.).	167-168
L-10 Discussion. H. F. Winterkorn. (U.S.A.).	168-169
L-11 Discussion. Muck Settlement Under Highway Fills. Earl F. Bennett. (U.S.A.).	169-170
L-12 Discussion (By Letter). Effect of Freezing and Thawing of Soil under Foundations of Cold Storage Warehouse. E. A. Dockstader. (U.S.A.).	171-173
L-13 Frost Action in Soils and Its Relation to Highway Engineering. Gunnor Beskow. (Sweden).	173
 <u>Section M:</u> METHODS FOR IMPROVING THE PHYSICAL PROPERTIES OF SOILS FOR ENGINEERING PURPOSES, INCLUDING RECENT DEVELOPMENTS IN CONSTRUCTING AND COMPACTING EARTH FILLS	
M-5 Comparative Studies of the Effectiveness of Different Methods for Compacting Cohesionless Soils. Wilhelm Loos. (Germany).	174-179
M-6 Opening Discussion. Karl v. Terzaghi. (Austria).	180-182
 <u>Section N:</u> MODERN METHODS OF DESIGN AND CONSTRUCTION OF FOUNDATIONS	
N-10 The Foundations of the San Francisco-Oakland Bay Bridge. Carlton S. Proctor. (U.S.A.)	183-193
N-11 Foundation of Modern Bridges in Denmark. Aage E. Bretting. (Denmark).	193-201
N-12 Experiences in the Construction and Working of Mercantile Harbours at Bremen and Bremerhaven and their Value in the Design of New Structures. A. Agatz. (Germany).	201-215
N-13 The Foundation of the Building "La Balaise" in Lugano, Switzerland Involving Modern Methods in Deep Foundation Technique. G. D. Rodio. (Italy).	215-225
N-14 Opening Discussion. Lazarus White. (U.S.A.).	226-228
N-15 Discussion on the Movements Within Foundation Pits During Construction. J. A. Cuevas (Mexico), Lazarus White (U.S.A.) and Karl v. Terzaghi (Austria).	228-231
N-16 Discussion. Paul E. Raes. (Belgium).	231-233
N-17 Foundation Conditions in Mexico City. Jose A. Cuevas. (Mexico).	233-237
 <u>Section Z:</u> MISCELLANEOUS	
Z-22 Discussion. Karl v. Terzaghi. (Austria).	238
Z-23 Discussion of Paper No. N-6 (By Letter). Irving B. Crosby. (U.S.A.).	238-239
Z-24 Discussion (By Letter). Maurice Buisson. (France).	239-240
Z-25 Discussion (By Letter). Karl R. Kennison. (U.S.A.).	240
Z-26 Discussion of Paper No. Z-17 (By Letter). Proposed New Boston Building Code. Karl v. Terzaghi. (Austria).	240-242
Z-27 A Preliminary Investigation into the Subject of Foundations in the 'Black Cotton' and 'Kyatti' Soils of the Mandalay District, Burma. D. Woollorton. (India).	242-256
Z-28 Discussion of Paper No. Z-27 (By Letter). W. E. Simpson. (U.S.A.).	257

	Page
Z-29 Report on a Joint Meeting of the Committee on Foundations and Soil Mechanics of the Society for the Promotion of Engineering Education and of the Committee on the Standardization of Symbols and Conventions.	258
Z-29a Opening Discussion. A. Casagrande. (U.S.A.).	258-261
Z-29b Discussion on Instruction in Soil Mechanics. Karl v. Terzaghi. (Austria).	261-263
Z-29c Discussion. Herbert Ensz. (U.S.A.).	264
Z-29d Discussion. E. E. Bauer. (U.S.A.).	264-265
Z-29e Discussion. W. P. Kimball. (U.S.A.).	265
Z-29f Discussion. Frederick J. Converse. (U.S.A.).	265-266
Z-29g Discussion. D. Krynine. (U.S.A.).	266
Z-29h Discussion. Robert G. Hennes. (U.S.A.).	266-267
Z-29i Discussion. Donald M. Burmister. (U.S.A.).	267-268
Z-30 Discussion of Paper No. Z-4 (By Letter). O. Godskesen. (Denmark).	268

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Appendix

LIST OF PAPERS DISCUSSED

Paper No.	Author	Discussion Contained in	Paper No.	Author	Discussion Contained in
A-25	Rutledge	Z-24	F-13	Favret	F-21
B-3	Barentsen	B-16	F-14	Fischer	F-30
B-6	Stanton	B-13, B-16	G-1	Wang	G-20
B-7	Cuperas	B-16	G-2	Hennes	G-19, G-20
C-2	Freeman	D-17	G-3	Middlebrooks	G-18, G-20
C-3	Andrews	D-30	G-4	Taylor & Vaidhianathan	G-20
C-6	Rutledge	D-35	G-6	Terzaghi	G-16
D-1	Tschebotareff	D-19, D-29, D-30, D-35	G-9	Jaky	G-16
D-2	Cooling & Smith	D-22, D-29	H-1	Raes	H-11
D-4	Gerservanoff	D-29	H-2	Kanschin & Plutalow	H-17
D-6	Endell & Hoffmann	D-31	H-5	Lozovsky	H-16
D-7	Terzaghi	D-31	I-5	R. Tillman	H-19
E-1	Tschebotareff	E-13	J-1	Spangler	J-9, J-11, J-12
E-2	Relton	E-13	J-3	Terzaghi	J-10
E-4	Krynine	E-20	K-2	Vreedenburgh	K-9
F-2	Converse	F-30	K-3	Mayer	K-8
F-4	Kimball	F-22, F-23	N-6	Terzaghi	Z-22, Z-23
F-6	Krynine & Nord	F-27	Z-17	Committee	Z-26
F-8	Ringeling	F-25	Z-18	Knappen & Phillippe	Z-24
F-12	Clark & Watson	F-21	Z-27	Wooltorton	Z-28

COMPLETE AUTHOR INDEX FOR VOLUMES I, II, & III

Abeloff	Z-6	Fehlmann	B-8	Parsons	D-13
Agatz	Vol. III, p. 21, N-12	Fellenius	D-36	Petermann	J-6
Andreae	A-1	Fischer	E-7, F-14, F-26	Pfeiffer	M-1
Andrews	C-3, D-30	Franx	H-3	Phillipe	Z-18
Bachy	M-4	Freeman	C-2	Pietkowski	H-9
Baahr	L-6	Froehlich	Z-10	Plutalow	H-2
Bakenhuis	H-18	Gersevanoff	D-4	Pogany	Z-13
Baker	E-9	Gilboy	G-11, Z-19	Pokrovsky	E-5, Z-9
Barentsen	B-3	Glick	E-17, N-2	Porter	L-1, L-7
Barkan	Z-8, Z-9	Godskesen	A-11, Z-4, Z-29	Proctor	H-13, N-1, N-10
Bauer	Z-30d	Gottstein	F-29, G-17	Raes	H-1, H-11, N-16
Begemann	A-21	Graftio	N-3	Rapp	E-9
Bennett	B-11, L-11	Gray	D-14, E-10	Relton	E-2
Beskow	L-13	Hanna	B-4, C-1, F-1, H-12	Rendulio	D-27
Biamond	F-9	Hartman	A-8	Ringeling	F-8
Boonstra	L-2	Haugeto	H-14	Rodio	N-13
Borwicka	E-8	Hennes	G-2, G-19, Z-30h	Royer	L-2
Bonlichev	A-10	Hoffmann	D-6, M-3	Russell	B-13
Bretting	Z-5, N-11	Hogentogler	A-15, D-20, L-9	Rutledge	Vol. III, p. 8, A-25, C-6
Brinkhorst	F-10	Hogentogler, Jr.	D-24	Samsioe	D-3
Broekman	G-5	Hough	E-16	Schmitt	Vol. III, p. 19
van Bruggen	B-2	Housel	A-6, A-15, F-24	Simpson	Z-28
van der Brught	D-5	Hvorslev	D-11, D-28	Small	Z-17
Buchanan	A-23, B-14	Immerman	N-7, N-8, Z-11	Smith	B-5, D-2
Buisman	F-7, G-5	Jaky	G-9, Z-16	Smolik	D-26
Buisson	D-10, D-29, F-25, Z-24	Jenkins	A-7	Solakian	G-18
Burmister	A-13, B-12, D-17, E-14, F-17, G-13, K-7, Z-29i	Jennings	J-10	Spangler	J-1, L-3
Casagrande, A.	Vol. III, p. I, p. 11, D-33, D-34, J-7, Z-30a	Jurgenson	G-8, Z-21	Stanton	B-6
Casagrande, L.	F-28	Justin	K-5	Steinbrenner	E-6
Chatley	Z-2	Kansohin	H-2	Stevens	K-1, K-9
Clarke	F-12, I-4	Kennison	Z-25	Stokstad	L-6
Conant	Vol. III, p. 11	Kimball	A-16, D-18, F-4, F-22, F-23, Z-1, Z-30e	Szily	D-25
Converse	F-2, Z-30f	Kjellman	A-4	Taylor	D-15, G-4, G-16
Cooling	B-5, D-2, D-22	Knappen	G-12, Z-18	Ter-Stepanian	D-8
Cox	Z-12	Kogler	E-12	Terzaghi	Vol. III, p. 13, p. 22, D-7, F-16, F-21, F-22, G-6, G-7, J-3, J-4, J-5, J-8, M-6, N-6, N-15, Z-3, Z-20, Z-22, Z-26, Z-30b
Crandall	H-6, H-7	Kretschmer	H-17	Tillmann	C-5, F-15, F-18 F-19, I-5
Creager	K-6	Krynine	A-5, E-3, E-4, E-15, E-20, F-6, H-16, J-12, Z-30g	Tschebotareff	D-1, D-19, E-1, F-1, H-12
Crosby	Z-23	Langer	D-9	Vaidhianathan	G-4
Cuevas	N-5, N-15, N-17	Ledesma	F-11	Vattenbyggnadsbyran	N-3
Cummings	H-11, J-11	Leggett	H-15, J-2, J-13	Vaughan	A-14, B-15
Cuperas	B-7	Loos	F-20, M-5	Vreedenburgh	K-1, K-2
Dawson	F-3	Lozovsky	H-4, H-5	Wang Yen	G-1
Daxelhofer	K-8	Mackintosh	L-8	Warlam	D-12
Dean	I-6	Marston	G-10	Watson	F-12, I-4
Dockstader	L-12	Mason, A.B.	E-11	Weston	M-2
Dore	Z-15	Mason, J.G.	H-8	White	D-32, H-10, N-9 N-14, N-15
Ehrenberg	G-14	Middlebrooks	D-31, E-19, F-27, G-3, G-15	Winsor	Z-14
Ekblaw	D-21	Mindlin	E-13, J-9	Winterkorn	D-16, D-23, L-10
Endell	D-6, M-3	Mohr	B-9	Wooltorton	Z-27
Engelund	N-4	Moran	Vol. III, p. 18, B-10	Yamaguti	A-12
Ensz	Z-30c	Morton	L-4, L-5		
Faber	I-3	Nord	F-5, F-6		
Favret	F-13	Ostashev	K-4		
Fedorov	E-5				

Corrections and Additions for Vol I and II

Paper No.	Vol	Page and Line	Correction or Addition
	I	VI	In the Author Index add O. Godskesen Z-4 and change O. Stokstad from K-6 to L-6.
C-1	I	23	The author of this paper, Dr. W. S. Hanna, is Head of the Foundation Soils Research Laboratory, Faculty of Engineering, Egyptian University, Giza, Cairo.
C-1	I	24 2	Should read 0.4 to 1.4 kg/cm ²
C-3	I	31 4	The Plasticity Index in column #7 should read 60.1.
D-1	I	33	The author of this paper, Dipl. Ing. G. Tschobotareff, is Research Engineer in the Foundation Soils Research Laboratory, Faculty of Engineering, Egyptian University, Giza, Cairo.
D-1	I	34 52	Should read Kamal Khalifa Eff.
D-4	I	48 63	Should read q = q ₀
D-4	I	50 1	Should read $\frac{q}{p} = \zeta + \frac{q_0}{p}$
D-4	I	50 17	Should read $\epsilon + \frac{a}{1+2\zeta} (R+S+U) = \text{const.}$
D-6	I	53	The position of the two X-ray photographs should be reversed. In Table II reference should be made to Fig. 3 instead of Fig. 2.
D-13	II	133	The investigation was carried out with a grant of \$500 which the Harvard Graduate School of Engineering received from the Committee on Earths and Foundations of the American Society of Civil Engineers of which Mr. Lazarus White is Chairman.
E-10	II	159	For the three equations at the bottom of this page the quantity appearing under the radical should be: $\sqrt{\frac{1}{4}(\sigma_x - \sigma_z)^2 + \tau_{xz}^2}$
F-6	I	100 32	Paragraph 3. The sentence should read "The bridge is a double <u>leaf</u> bascule span".
G-2	I	134	Fig. 1. The legends in German for L ₀ and L _f are reversed and should be revised to correspond with the facts and with the English legends.
G-3	I	137 15 13 & 14	Fig. 15 should read Fig. 14. Titles for Figs. 14 and 15 are reversed.
G-5	I	150 53	"Deducted" should read <u>deduced</u> .
G-8	II	199 59	Should read $c + \frac{P a}{B L^2}$
G-8	II	199 54	Should read $p = 2 (\pi + 2) c$
G-8	II	200 4	Should read $c = \frac{P a}{B L (L + \pi a)} = \frac{P a}{B L^2 (1 + \frac{\pi a}{L})}$
J-1	I	207	Formula (2) should read as follows: $h_0 = \frac{3}{2\pi} \cdot P \cdot \frac{x^2 z}{r^5} \quad (\text{when } m = 2) \dots \dots \dots (2)$
M-1	I	263	Add the following: All the operations at the Assiut Dam were carried out by Messrs. Cochrane of London, and the injection work was subcontracted to the Francois Cementation Co., in Doncaster, Great Britain.
M-3	I	274 2	Should read "Atterberg's liquid limit and the angle of internal friction are <u>decreased</u> by treatment".

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