

# soil mechanics

January 2021

Theme 7

INTRODUCTION TO  
GEOTECHNICAL & SOIL  
MECHANICAL



KARL VON TERZAGHI  
Fathers of soil mechanics  
& geotechnics



History of GEOTECHNICAL  
ENGINEERING

## FATHERS of SOIL MECHANICS & GEOTECHNICS



ON TERZAGHI

BRAZELTON PECK SKEMPTON DOKUCHAEV CASAGRANDE

FRÖHLICH GAUTIER DUNNICLIFF S  
JOHN MACLORN RANKINE

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# KARL VON TERZAGHI

FATHER OF SOIL MECHANICS & GEOTECHNICAL ENGINEERING





## *The Legend of Karl von Terzaghi*

Karl Terzaghi, (born Oct. 2, 1883, Prague—died Oct. 25, 1963, Winchester, Mass., U.S.), civil engineer who founded the branch of civil engineering science known as soil mechanics, the study of the properties of soil under stresses and under the action of flowing water. He studied mechanical engineering at the Technical University in Graz, graduating in 1904, then worked as an engineer for several years; he was awarded a doctorate in engineering by the same institution in 1911. After visiting the United States, he served in the Austrian Air Force during World War I, but in 1916 he accepted a position with the Imperial School of Engineers, Istanbul. When the war was over, he took a post (1918–25) with Robert College, a U.S. institution, also in Istanbul. Much research had been done on foundations, earth pressure, and stability of slopes, but Terzaghi set out to organize the results and, through research, to provide unifying concepts. The results were published in his most noted work, *Erdbaumechanik* (1925; *Introduction to Soil Mechanics*, 1943–44). In 1925 he went to the United States, where—as a member of the faculty of the Massachusetts Institute of Technology, Cambridge—he worked unceasingly for the acceptance of his ideas, serving also as consulting engineer for many construction projects. In 1929 he accepted the newly created chair of soil mechanics at Vienna Technical University. He returned to the United States in 1938 and served as professor of civil engineering at Harvard University from 1946 until his retirement in 1956. His consulting practice grew to encompass the world, including the chairmanship of the Board of Consultants of Egypt's Aswān High Dam project until 1959.

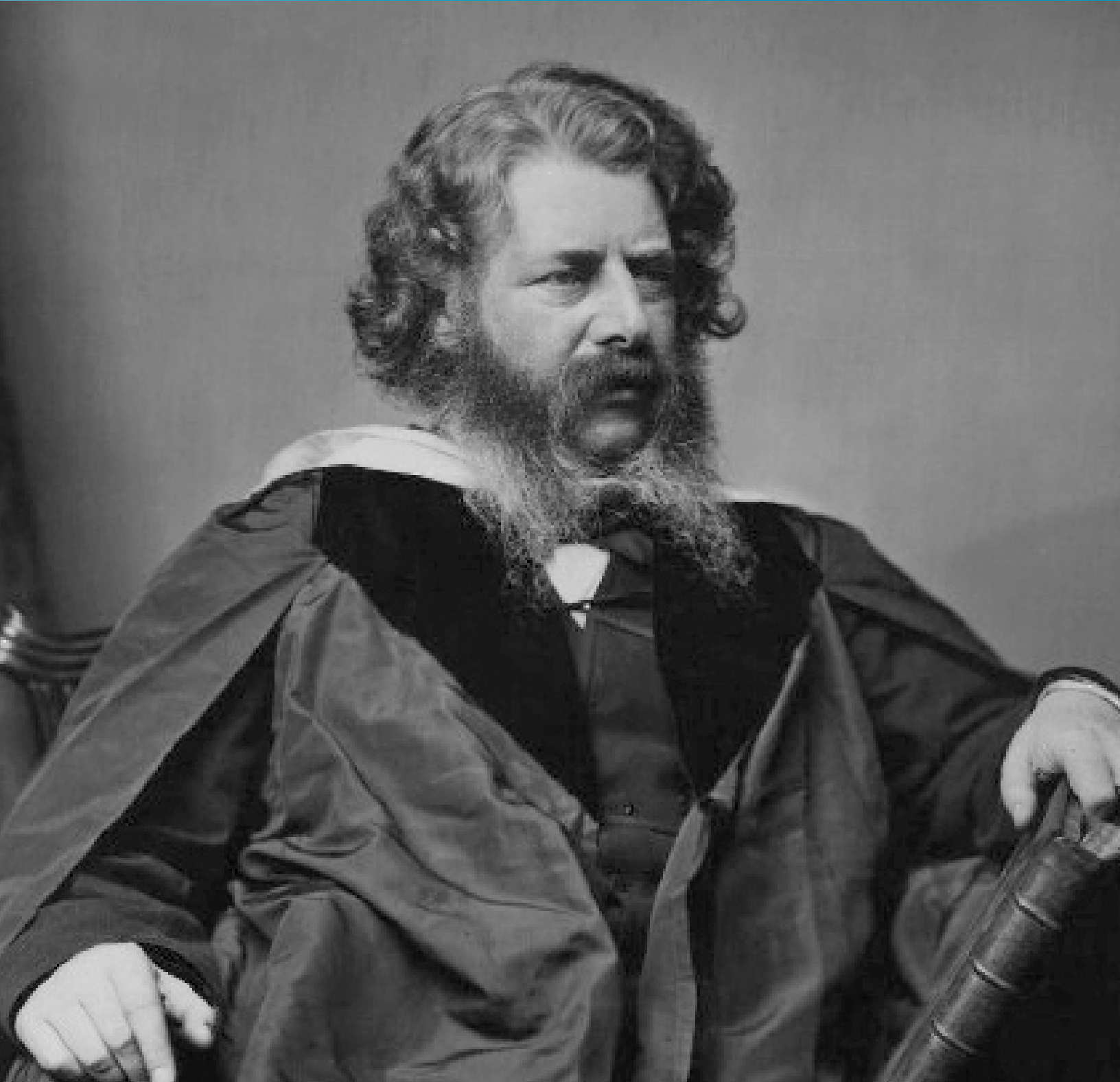


***"Unfortunately, soils are made by nature and not by man, and the products of nature are always complex"***

*MECHANICAL ENGINEER CONTRIBUTED TO CIVIL ENGINEERING, PHYSICS AND MATHEMATICS*

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# WILLIAM JOHN MACQUORN RANKINE



# BIOGRAPHY

William John Macquorn Rankine



Discrepancy between theory and practice, which in sound physical and mechanical science is a delusion, has a real existence in the minds of men; and that fallacy, through rejected by their judgments, continues to exert and influence over their acts.

AZ QUOTES

*"The law of conservation of energy is already known, viz. that the sum of actual and potential energies in the universe is unchangeable."*

William John Macquorn Rankine, (born July 5, 1820, Edinburgh, Scot.—died Dec. 24, 1872, Glasgow), Scottish engineer and physicist and one of the founders of the science of thermodynamics, particularly in reference to steam-engine theory. He trained as a civil engineer under Sir John Benjamin MacNeill, Rankine was appointed to the Queen Victoria chair of civil engineering and mechanics at the University of Glasgow (1855).

One of Rankine's first scientific works, a paper on fatigue in metals of railway axles (1843), led to new methods of construction. His Manual of Applied Mechanics (1858) was of considerable help to designing engineers and architects. His classic Manual of the Steam Engine and Other Prime Movers (1859) was the first attempt at a systematic treatment of steam-engine theory. Rankine worked out a thermodynamic cycle of events (the so-called Rankine cycle) used as a standard for the performance of steam-power installations in which a condensable vapour provides the working fluid. In soil mechanics his work on earth pressures and the stability of retaining walls was a notable advance, particularly his paper "On the Thermodynamic Theory of Waves of Finite Longitudinal Disturbance."

# Who is Ralph B. Peck?

Ralph B. Peck was born in Winnipeg, Canada on 23rd June 1912. He passed away because of congestive heart failure on 18th February 2008. Ralph B. Peck earned Civil Engineering Degree in 1934 and Doctor of Civil Engineering Degree in 1937 from Rensselaer Polytechnic Institute in Troy, New York. In 1938, he attended Soil Mechanics classes at Harvard and was a laboratory assistant to Arthur Casagrande. At this time Dr. Karl Terzaghi became a consultant to the City of Chicago for the design and construction of the Initial System of Chicago Subways and Peck became his representative on the job. Professor Peck's main interest has been observation of the behavior of earth and rock during construction and under stress. Since 1974, Professor Peck was a Professor Emeritus at the University of Illinois, and a consultant in geotechnical engineering.

In 1948, he was the co-author of "Soil Mechanics in Engineering Practice" along with Karl Terzaghi and the widely used text book "Foundation Engineering" with Walter E. Hanson and Thomas H in 1953. He also author of of more than 200 technical papers and some of them are included in the book "Judgment in Geotechnical Engineering - The Professional Legacy of Ralph B. Peck" (1984) and "Ralph B. Peck: Educator and Engineer - The Essence of the Man" (2006).


## Contribution & award:

- 1969-1973: SERVED AS THE PRESIDENT OF THE INTERNATIONAL SOCIETY OF SOIL MECHANICS AND FOUNDATION ENGINEERING
- 2000: THE FIRST HERO OF THE GEO-INSTITUTE OF ASCE
- A MEMBER OF THE NATIONAL ACADEMY OF ENGINEERING
- MORE THAN ONE THOUSAND CONSULTING PROJECTS INCLUDED JOBS IN FORTY-FOUR STATES IN THE USA AND TWENTY-EIGHT COUNTRIES ON FIVE CONTINENTS
- CONSULTING PROJECT INCLUDE: THE RAPID TRANSIT SYSTEMS IN CHICAGO, SAN FRANCISCO, AND WASHINGTON; THE ALASKAN PIPELINE SYSTEM; THE JAMES BAY PROJECT IN QUEBEC; AND THE DEAD SEA DIKES
- NATIONAL MEDAL OF SCIENCE BY PRESIDENT FORD
- NORMAN MEDAL
- THE WELLINGTON PRIZE
- THE KARL TERZAGHI AWARD
- PRESIDENT'S AWARD OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS
- THE 1972 NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS' AWARD
- THE 1973 MOLES NON-MEMBER AWARD
- THE 1983 GOLDEN BEAVER AWARD
- THE 1976 WASHINGTON AWARD

Professor Harry Bolton Seed was born in Bolton, England on 19th August 1922. He passed away on April 1989. Harry Bolton Seed was known internationally for his understanding of soil behavior during earthquakes and for sharing that expertise through teaching and consulting. After military service, he completed a PhD in structural engineering by 1947. During this period Harry Bolton Seed captained the University of London's soccer team, and was selected as captain of the All-England team. Shortly after completing his degree, Seed heard about the cutting edge work being done on soil mechanics by Karl Terzaghi and Arthur Casagrande . Acutely aware of the significance of the new field to his understanding of structures, he left London and received a second degree in soil mechanics from Harvard under the tutelage of the two innovative scholars. His Harvard education was followed by a year as a foundation engineer for the Boston based Thomas Worcester, Inc. In 1950, he joined the civil engineering faculty at the University of California, Berkeley as a teacher, researcher, and consultant for 40 years. He introduced the field of geotechnical earthquake engineering in 1960. He was one of the country's brightest and most productive young civil engineers by the time of the great Alaska earthquake in 1964, he immediately began research that led to an understanding of soil behavior and ground response during earthquakes that is the basis for present-day seismic design around the world. He had given many contributions in the fields of structural and geotechnical engineering, highway engineering, and earthquake engineering. And, he became chairman of the entire Civil Engineering Department in 1965.

# *Harry Bolton Seed*

*father of geotechnical earthquake engineering*



Harry Bolton Seed served as a consultant on projects all over the world and investigated major disasters, such as the 1971 San Fernando earthquake in California, the 1976 failure of the Teton dam in Idaho, and the 1985 Mexico City earthquake.

# Contribution & Award

- 1987: received the National Medal of Science, the nation's highest scientific honor, from President Reagan
- contributions to analytical methods of pavement design
- research on soil compaction and the influences of methods of compaction on soil structure and mechanical properties
- Write nearly 300 papers and reports

## AWARD:

- the Norman Medal twice
- the James J. R. Croes Medal three times
- the Thomas A. Middlebrooks Award four times
- the Thomas Fitch Rowland Prize
- the Wellington Prize
- the Walter A. Huber Research Prize
- the Karl Terzaghi Award
- Distinguished Teaching Award from the University of California and more



# ALBERT MAURITZ ATTERBERG

scientist who created Atterberg Limit



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FATHER OF SOIL  
MECHANICS  
AND  
GEOTECHNICAL

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Albert Atterberg received his Ph.D. in chemistry from Uppsala University in 1872 and stayed there as a lecturer in analytical chemistry until 1877, during which time he toured Sweden and abroad to study the latest developments in organic chemistry. In 1877, he became the director of the Agricultural Research Institute in Kalmar. He then went on to become the principal of the Chemical Station and Seed Control Institute at Kalmar, publishing numerous papers on agricultural research dealing with the classification of varieties of oats and corn between 1891 and 1900.

He began to focus his efforts on the classification and plasticity of soils, of which he is most remembered for at the age of fifty-four while continuing his work on chemistry. Albert Atterberg was apparently the first to suggest the limit  $<0.002$  mm as a classification for clay particles. He found that plasticity to be a particular characteristic of clay and as a result of his investigations arrived at the consistency limits which bear his name today. He also conducted studies aiming to identify the specific minerals that give a clayey soil its plastic nature. And finally in 1911, he introduced "Atterberg Limits" the consistency limits of soils (shrinkage limit, plastic limit and liquid limit). He was credited for determining that plasticity is a particular characteristic of clay, the most complex and unpredictable type of soil.

Born on March 19, 1846 in Härnösand. He passed away on April 4, 1916 in Kalmar. He was a Swedish chemist and agricultural scientist who created the Atterberg limits that are commonly referred to by geotechnical engineers and engineering geologists today.

Atterberg's work on soil classification gained formal recognition from the International Society of Soil Science in a Berlin Conference in 1913. Two years later a U.S. Bureau of Standards report stated that Atterberg's method was as "as simple a one as could be devised, and it is well that we should become familiar with it." The U.S. Bureau of Chemistry and Soils adopted it in 1937.

FATHER OF SOIL MECHANICS AND GEOTECHNICS

# ALEC SKEMPTON



A. W. Skempton

GEOTECHNICAL & CIVIL ENGINEER

# SIR ALEC SKEMPTON

**SIR ALEC WESTLEY SKEMPTON** was born on 4 June 1914 in Northampton. He attended Waynflete House Preparatory School, Northampton. From 1928, he attended Northampton Grammar School. In 1932, Alec became an undergraduate in the Department of Civil Engineering at Imperial College and graduated with first class honors in 1935. Alec Skempton returned to the Imperial in 1947 to become Reader in Soil Mechanics at the invitation of Sutton Pippard. He was awarded the higher doctorate of DSc from the University of London. At year 1955, Alec Skempton became Professor of Soil Mechanics and took the title of Professor of Civil Engineering after becoming Head of Department of Civil Engineering in 1957. He then retired at the age of 67.



SIR ALEC WESTLEY SKEMPTON (1914-2001)

His career as geotechnical engineer began in 1946 at the Building Research Station at Garston and was appointed to the College staff. Alec has made a great contribution to the field of Quaternary Geology and was widely consulted on problems involving embankments, retaining walls, foundations and landslips. He also worked on the large dam at Mangla in Pakistan and on investigating the failure which developed during construction at the Carsington Dam in Derbyshire in 1984. Then, in year 1957, he was elected as the second President of the International Society for Soil Mechanics and Foundation Engineering.

Skempton had been a member of the Soil Mechanics Group at BRS for a few months. In 1948, the second International Conference at Rotterdam he had had profited by Terzaghi's lead. In 1948 he was part author of no less than 10 papers and 7 of them published in the conference proceedings. It was the period of analysis in terms of total stresses, particularly of short term failures of slopes and foundations and the measurements of the undrained strength of soft clays to apply to these problems. From these, came some of his previous work on the classification and inter-relationship between soil properties, appropriately the very first paper in the first number of *Géotechnique*, on the geotechnical properties of post-glacial clays. This work then led to the surprising conclusion that  $S_u$  would normalise with  $\sigma'_v$ , so that  $c/p$  (to use Skempton's terminology) was constant with depth for such clays, and in turn could often be correlated with plasticity index.

Professor Sir Alec Westley Skempton died on 9 August 2001, full of years and honours, active to the end. He was a legend in his own time, one of the founding fathers of our discipline of soil mechanics.

# VASILY DOKUCHAEV

RUSSIAN GEOLOGIST AND GEOGRAPHER



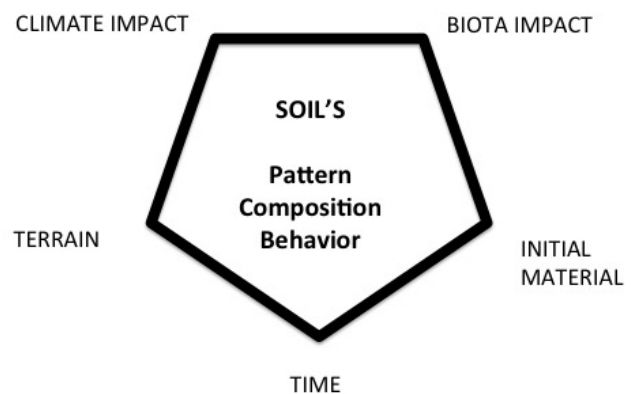
**VASILY VASILIECH DOKUCHAEV** was known to be one of the fathers in Soil Mechanics and geotechnical engineering. Vasily came from a family of village priest. He had his elementary education at school in Vyazma, a town in Russia. He then continued to study at Smolensk seminary and graduated in 1867. Vasily had been accepted at St. Petersburg Ecclesiastical Academy but then left from became priest to enter physics and mathematics industry at Petersburg University. Vasily graduated with master's degree in 1871. Dokuchaev carried out some researches and was devoted to the study of alluvial deposits near his birth place which was Kachna River, on the upper reaches of the Volga. His scientific activity was connected with his former university and other societies such as the Society of Natural Scientists, the Free Economic Society, the Mineralogical Society, and the Petersburg Assembly of Agriculturists. With the supports he get from these societies, he then carried out research on the Russian plain and in the Caucasus.

**Born: 1 March 1846**  
**Milyukovo, Russia**

**Died: 8 November 1903 (57),**  
**St. Petersburg, Russia**

Dokuchaev became a curator of geology at University of St. Petersburg in 1872. In 1879, he became a Privatdozent in geology and entered the geology faculty and developed the first course in Quaternary geology taught at a university. He reorganized and directed Novo-Aleksandr Institute of Agriculture and Forestry from 1892 to 1895 by adding departments of soil sciences and plant phycology. He was the one who introduced the term of chernozem to describe black soil, carbonate and humus-rich that occurs in Russia's temperate latitudes. He viewed soil as the result of interaction between organisms, bedrock and climate. In 1898, he implemented a Russian soil classification that illustrated that, depending on the climate, identical bedrocks give rise to different soils. The biome theory was predicted by his focus on relationships between bedrock, climate, and organisms.

## DOKUCHAEV'S FIVE NATURAL SOIL-FORMING FACTORS





FATHER OF SOIL MECHANICS & GEOTECHNICAL

# PETER WROTH

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World pioneer in Geotechnical  
Engineering and Soil Mechanics

**British Civil Engineer**

## About

# PETER WROTH

CHARLES PETER WROTH was born in 1929. He received an education at Marlborough and as a scholar at Emmanuel College, Cambridge. Wroth worked briefly as a teacher at Felsted School on graduating before returning to Cambridge as a research student under the dynamic leadership of Ken Roscoe. After receiving his PhD in 1958, he left with Maunsell and Partners to gain industrial training and experience as a civil engineer; his contribution was primarily to the design and development of the Hammersmith flyover-work of pre-stressed concrete that led to some early publications and of which he was always proud. He returned to Cambridge as a lecturer in 1961, and became a Fellow of Churchill College in 1963.

Peter Wroth contributed greatly to soil mechanics and civil engineering generally as teacher, researcher and administrator. Wroth was author or co-author of one book and over ninety papers and reports including several general reports on a wide variety of subjects and a number of special lectures, of which the most important was the Rankine Lecture in 1984. The key topics

covered by his research were the development of soil constitutive models, in situ soil processing, and the study and construction of piles, while he also made significant contributions to earth pressure and retention wall theory, soft-ground embankments, hardened soil and connections between index properties and soil engineering behaviour. He was also one of the first to appreciate the potential for numerical methods of analysis (such as finite elements and the method of characteristics) in the solution of complex boundary-value problems in geotechnical engineering.

His doctoral and other early studies at Cambridge contributed significantly to the growth of critical state soil mechanics and the different soil models that arose from it. Any of the most important theories in soil mechanics in the past 50 years are the unifying principles of CSSM, which underpinned almost all of Peter's other work.

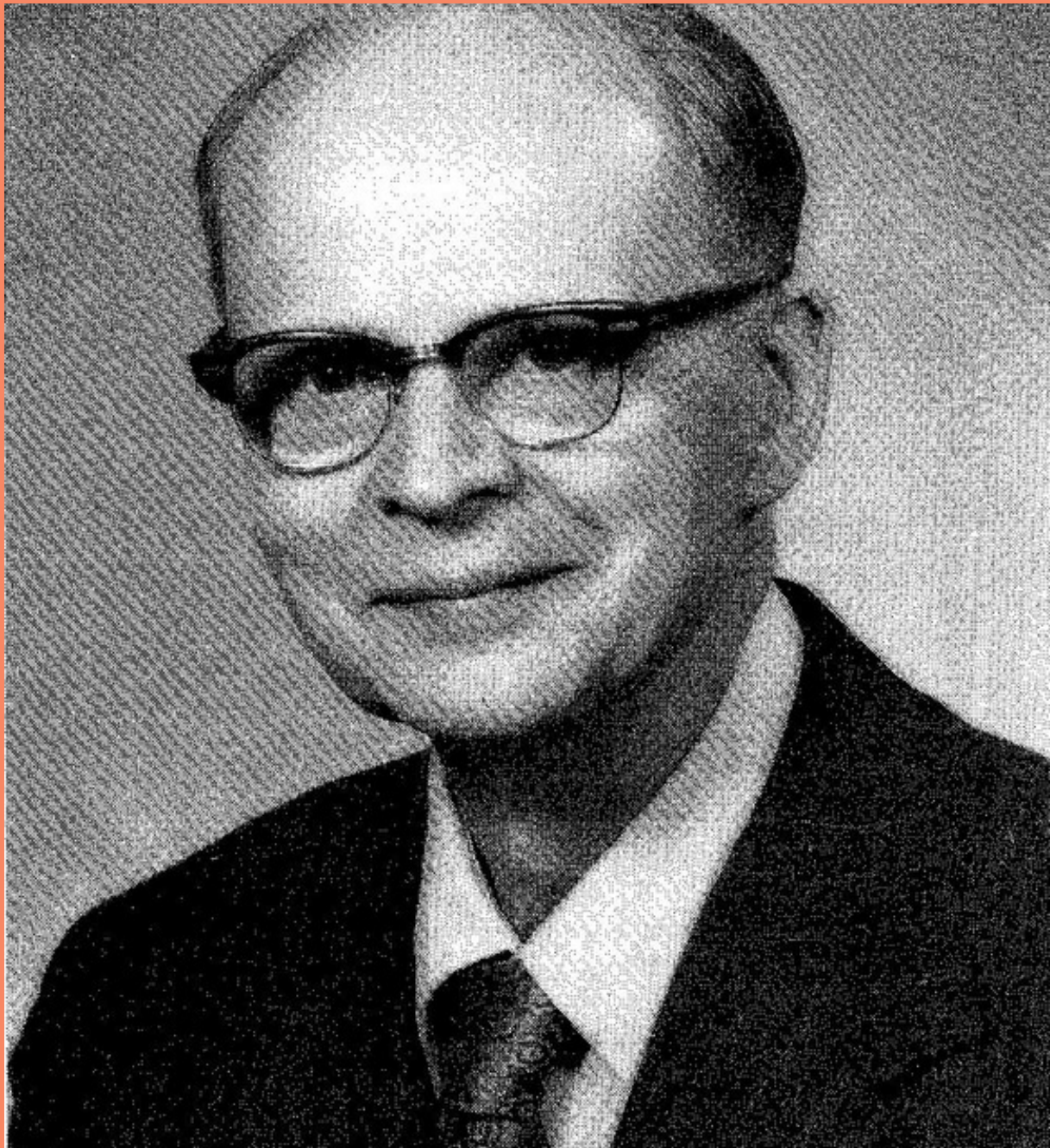
When Peter Wroth died on 3 February 1991, after a short illness, the world of soil mechanics lost one of its major figures. His contribution was internationally recognized, and had he survived he would undoubtedly have added further to it.

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# ARTHUR CASAGRANDE

AMERICAN-AUSTRIAN CIVIL ENGINEER



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AUGUST 1902 - SEPTEMBER 1981

# 'RIGHT HAND' OF KARL TERZAGHI

As one of the pioneers in the area of earth fill dam design, the name **ARTHUR CASAGRANDE** cannot be separated from that of his fellow countryman, mentor, and colleague, **KARL TERZAGHI**. Together, Casagrande and Terzaghi built the influential discipline of soil mechanics and were personally responsible for the application of their groundbreaking theories to hundreds of large-scale construction projects in America and abroad.

Arthur Casagrande was born in the Italian section of the Austria-Hungary Empire in 1902. Casagrande was a violin prodigy as a child, but as he matured his interests shifted from music to engineering. He received his education on civil engineering with an emphasis on hydraulics.

In the summer of 1924 while visiting the Massachusetts Institute of Technology (MIT) to apply for position in hydraulic engineering, Casagrande met Karl Terzaghi by chance. After the two countrymen discussed Terzaghi's new book *Erdbaumechnik auf Bodenphysikalischer Grundlage* (The Mechanics of Earth Construction Based on Soil Physics), Terzaghi asked Casagrande to serve as his research assistant on a consulting project for the U.S. Bureau of Public Roads. He came to the United States in 1926 and settled for good. He was the 'right hand' of Terzaghi for several years and made, or contributed to making, the fundamental developments of Soil Mechanics.

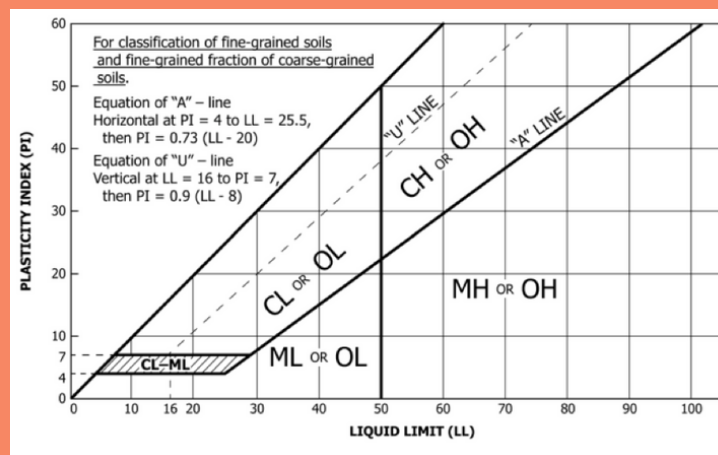


*From left: Karl Terzaghi, Leo Casagrande and Arthur Casagrande*

# CONTRIBUTION IN SOIL MECHANICS

From 1940 to 1942, Casagrande trained more than 400 army officers on the soil mechanics aspects of airfield construction. During this period, he also developed a soil classification system, which was later adopted by the Corps of Engineers and by the Bureau of Reclamation as the United Soil Classification System (USCS).

One of his famous work is the Casagrande plasticity chart. It has been used for more than 70 years to classify fine-grained soils in accordance with USCS. It is safe to assume the "A-Line" on the plasticity chart is after "Arthur". Casagrande was also renowned for his ingenious designs of soil testing apparatus and fundamental research on seepage and soil liquefaction, he is also credited for developing the soil mechanics teaching program at Harvard University during the early 1930's that has since been modelled in many universities around the world



A number of awards have been established in his honor including the Arthur Casagrande Professional Development Award (ASCE). ASCE is funded by gifts from the many students, colleagues, and friends of Arthur Casagrande. The award was established to provide professional development opportunities for outstanding young practitioners, researchers, and teachers of geotechnical engineering who are 35 years of age or less when nominated.

