

Three Musketeers in Soils Testing: Atterberg, Casagrande, and Terzaghi

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Posted: October 2014



Who in their right mind invented a test that involves making “worms” out of soil? Albert Atterberg, that’s who! The Atterberg limit tests, commonly known as liquid and plastic limit of soils, are named for Albert Mauritz Atterberg, a Swedish chemist and agricultural scientist. Atterberg was born in 1846. In 1872, he earned his Ph.D. in chemistry from Uppsala University in Sweden. Atterberg taught analytical chemistry at Uppsala for several years before becoming a principal of the Chemical Station and Seed Control Institute in Kalmar, Sweden.

Atterberg was a late bloomer when it came to soil classification. It wasn’t until he was in his mid-50’s that Atterberg turned his attention to the classification and plasticity of soils. He is credited for determining that plasticity is a particular characteristic of clay, the most complex and unpredictable type of soil. In 1913, Atterberg’s soil classification work received formal recognition from the International Society of Soil Science. He was 67 years old at the time and he passed away three years later.



Arthur Casagrande was born in 1902 in Austria, over a half century after Albert Atterberg. He attended the Technische Hochschule, a secondary school in Vienna from which he earned a degree in civil engineering in 1924. Casagrande’s father died that same year, after which Arthur became the sole financial provider for his entire family. Because construction work was scarce in Austria after World War I, Casagrande decided to move to the United States to follow his true passion of civil engineering, and to better support his family.

Having worked as a draftsman in New Jersey for a few months, Casagrande sought employment at the Massachusetts Institute of Technology (MIT). While interviewing at MIT in 1924, Casagrande met Karl Terzaghi, a civil engineer and geologist who also hailed from Austria.

 *Fun fact: Arthur Casagrande was a violin prodigy as a child!*



Karl von Terzaghi was born in 1883 in Prague, Czech Republic and later moved to Austria. After studying mechanical engineering in Austria, Terzaghi spent the next 20 years working in engineering and research in Austria, the United States and Turkey. He also happens to be the so-called “Father of Soil Mechanics.” Terzaghi’s theories of consolidation, bearing capacity, and stability led to the development of the civil engineering science known as soil mechanics, and to Terzaghi’s Principle:

$$\text{Total Stress} = \text{Effective Stress} + \text{Pore Water Pressure}$$

Fun fact: Terzaghi was nearly expelled from the university he first attended in Austria before going on to receive nine honorary doctorate degrees from universities in eight different countries!

Terzaghi accepted a position with MIT in 1924, the same year Casagrande ran into him there. Small world! As a result of their chance meeting at MIT, Casagrande was hired immediately as Terzaghi’s private assistant, and went on to become a full-time lecturer at MIT in 1926.

Casagrande worked for the US Bureau of Public Roads, which was assigned to MIT, for several years. It was there that he and Terzaghi conducted research to improve soil testing apparatus and procedures. Casagrande returned to Vienna in 1929 with Terzaghi to set up a soil mechanics laboratory. While in Europe, Casagrande spent time touring other soil mechanics laboratories there. Upon his return to MIT a few months later, Casagrande used the soil

mechanics knowledge he had gained in Europe to develop several key pieces of soil testing equipment, including the liquid limit apparatus and the shear box. Casagrande also developed the hydrometer test and was one of the first in the United States to conduct triaxial shear testing.

In 1932, Casagrande moved on from his work at MIT to become an assistant professor at Harvard University. That same year, Terzaghi encouraged Casagrande to obtain his doctorate in engineering science at the Technical University of Vienna. Returning to Harvard after earning his doctorate, Casagrande eventually became the chair of the soil mechanics and foundation engineering department in 1946. During World War II, the Army Corps of Engineers commissioned Casagrande to develop a unified classification system for soils, known today as the Unified Soil Classification System (USCS).

Terzaghi eventually moved back to the United States from Austria and joined Casagrande at Harvard. The two men worked together for 25 years, and both are credited with establishing soil mechanics as an essential part of civil engineering. In fact, Casagrande later became the first recipient of the Karl Terzaghi Award presented by the American Society of Civil Engineers (ASCE).

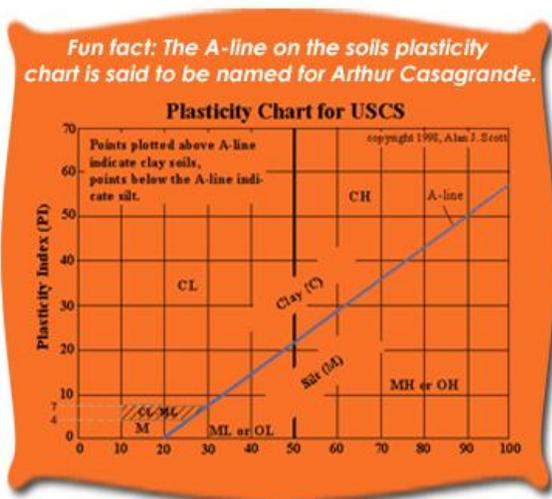
Linking Past and Present

The connection between these three men can be seen in the testing and classification of soil. Atterberg created the liquid and plastic limit tests, and Casagrande later refined them. When Atterberg developed the liquid limit test, it involved placing the soil pat in a porcelain bowl and cutting a groove in the soil with a spatula. The bowl was then struck against the palm of one hand to close the groove. Casagrande further developed the test by standardizing the apparatus and procedures, thus improving the repeatability of the test. The porcelain bowl was replaced with a metal cup, called the Casagrande cup, and the spatula was replaced with a flat grooving tool, also named for Casagrande. These modified pieces of equipment are still in use today.



Terzaghi completed the link by introducing Atterberg's work into the field of geotechnical engineering, with the help of Casagrande's research.

In terms of soil classification, Albert Atterberg developed the first soils classification system in 1900 which was later modified by Arthur Casagrande in 1932. This modified system (USCS) was adopted by the US Army Corps of Engineers and the Bureau of Reclamation in 1952.



Even though Atterberg and Casagrande likely never crossed paths during their careers, they had a significant impact on the materials testing community. The USCS is probably the most common soil classification system used in the world today, and it all started with Albert Atterberg nearly 115 years ago!

Timeline of Events



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