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Early History of Geotechnical Engineering

at

The University of Texas at Austin

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by
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Although soils and rocks were the first construction materials used there was little investigation and study of their behavior until Coulomb published a paper in 1776. This classical work is still used today but in a modified form. Following Coulomb's work there was little of real value given to the construction industry until Dr. Karl Terzaghi began his studies. He was born in Prague in 1883 and in 1904 graduated from the Technische Hochochule in Graz, Austria. He became Professor of Civil Engineering at American Roberts College in Istanbul, Turkey in 1918. Terzaghi was convinced that engineers must find means to describe soils quantitatively if they were to be used satisfactorily as a construction material. He developed research and test procedures to this end. He published his first book, "Erdbaumechanik" in 1925. His known as the father of modern Soil Mechanics and Foundation Engineering and was the leader of research and development throughout his entire life. While he, and all early engineers called it Soil Mechanics and Foundation Engineering later investigators felt that the broader term: Geotechnical Engineering was more descriptive of the science. In this paper the two titles will be used indiscriminately.

In order to review the development of Geotechnical Engineering at The University of Texas, it is necessary to include some of the early activities of my career. I graduated from Purdue University in 1923 with a Bachelor of Science Degree in Civil Engineering; and was employed by the Illinois Division of Highways. I was assigned to the Materials and Tests Division in Springfield.

At that time the Illinois Division of Highways was completing their classical research projects known as the Bates Experimental Road Tests. They had completed the test runs but were analyzing volumes of data. One question was the effect of the subgrade soils on the road test results. I was assigned the laboratory work on these materials. Very little was

known about the soil behavior and we had little precedent to follow. My supervisor thought that grain size was an influencing factor and we developed a crude test in an attempt to determine grain sizes.

In 1924 Dr. Terzaghi wrote a series of articles for the Engineering News - Record on the various tests used for soil identification. I immediately supplemented the grain size tests with the Atterberg Limits and other tests Dr. Terzaghi described. I concluded that the plasticity tests gave us the desired information but was unable to convince my boss of the need to change our procedures. Therefore I ran both grain size and plasticity tests on all samples. Fortunately both tests indicated little variance in the soil samples and we concluded that the subgrade soils had little influence on the road tests.

After two years on concrete research for the U.S. Bureau of Public Roads. Professor S. P. Finch offered me the position of Testing Engineer in the Bureau of Engineering Research at The University of Texas and I joined the staff on October 15, 1928. The University laboratory along with those at A & M were designated by the State Legislature as available for testing of materials for the State Highway Department. Being in Austin, The University laboratory did all of the work. I was in charge of the laboratory, located on the "Little Campus" at Nineteenth and Red River Streets and had one University employee and twelve to fifteen Highway employees under my supervision.

While carrying on the usual test, I had a very strong feeling that we were missing an important factor in not testing the subgrade soils. In 1929 I learned that the U.S. Bureau of Public Roads was establishing a soil testing laboratory near Washington, D.C. In December following the meeting of the Highway Research Board, I arranged to spend two weeks in the Public Roads Laboratory learning their test procedures, equipment design and sampling methods. In January, 1930 I established a soils laboratory in the Bureau of Engineering Research at The University of Texas. This was the third or fourth soil mechanics laboratory in the United States.

In 1933, just before Dean Woolrich came to Texas the commander of the U.S. Waterways Experiment in Vicksburg, Miss., told him there was only one Soil Mechanics Laboratory in all the area south of the Mason-Dixon Line and West of the Mississippi River - the one at The University of Texas.

Early in the Thirties the State Highway Department employed Frank H. Newnam Jr. and placed him in our laboratory to learn soil testing methods and the application of the test results to highway construction. A few years later the State Highway Dept. established their own laboratory with Mr. Newnam in charge of the soil section and expended their work to include testing of all subgrade soils, base materials and also foundations for bridges and structures.

The Bureau of Engineering Research expanded their soil research and testing in order to help Federal, State, City, County and Consulting Engineers to use the newly developed soil testing methods and procedures in their design and construction of engineered structures.

This was in the time of the great depression and equipment funds were severely limited. We wanted some new equipment that had been developed - it cost $600.00 and funds were not available. At that time Professor Stanley P. Finch was Director of the Bureau, so he and I made an appointment to see President Benedict and request a special appropriation of $600.00 to buy this equipment . One would think that we would not make a request to the President for so small a sum - however at that time it was equal to three months salary. professor Finch said, "Dr. Benedict we want to request a special appropriation for this work, if the University has the money." Dr. Benedict replies, "Stanley, the University always has the money - but we have more requests than money." We did not get the $600.00 but redesigned the equipment and the next year bought materials and made the instruments in the University shops.

An interesting source of money to buy these materials went back to the Highway Testing. Concrete cylinders had to be kept damp during shipping so Resident Highway Engineers would use the most readily

available materials to wrap them in. On the job this was cloth cement sacks. Also cement, sand, gravel and crushed stone were shipped in cement sacks. We cleaned and dried the sacks and returned them to the cement producers for a refund of 10 cents per sack. Over the years a sizable fund was built up and we were able to use this money to buy instruments, materials and pay for the Terzaghi lectures at the Second Texas Conference on Soil Mechanics and foundation Engineering. (see later part of this report).

In all of this work, I always had strong support and encouragement from Professor Stanley P. Finch. Without his help the program would have been difficult if not impossible.

In 1936 the First International Conference on Soil Mechanics and Foundation Engineering was held at Harvard University. I attended - also paid my own expense. We heard the latest papers, saw the newest developments in equipment and met Dr. Terzaghi, Dr. Casagrande and other prominent engineers in the filed. I gave a paper on some investigations we had started on the Texas State Centennial Buildings in Dallas. Following the Harvard Conference we developed new equipment, and added to our laboratory to an extent that we believed Texas Engineers would be interested in seeing our facilities. In January 1938 we held the first Texas Conference on Soil Mechanics and Foundation Engineering. We had expected only 25 to 30 engineers to attend and planned to show the equipment in the Soils Mechanics Laboratory and have the lectures in a small lecture hall. Registrations poured in at such a rate we realized we had to move to larger quarters. The lectures were moved to Hogg Auditorium and the laboratory equipment was moved to a large lecture - laboratory facility in Taylor Hall. Prominent Texas Engineers, namely Willard Simpson of San Antonio and R. J. Cummins of Houston participated in the Conference and professors Finch and Ferguson gave interesting papers. But the chief interest was the demonstrations of laboratory tests by the writer and helpers and the use of these results in engineering calculations. Over 130 engineers from Texas, Oklahoma, Nebraska, Louisiana and Kansas attended. At the end of this conference the

engineers unanimously supported a resolution requesting a second conference the following year.

The problem of finding a program for the Second Texas Conference was left to me and I was able to get Dr. Karl Terzaghi of Vienna and Boston to come and give three lectures on (1) "Earth Pressure Problem", (2) "The Use and Abuse of Piles in Foundations" and (3) "Some Experiences with Dams on Shale Foundations". Discussions of each lecture was given by engineers and geologist from this area. The meetings were held in the main ballrooms of the Texas Union. Over 250 engineers attended. Some interesting comments on the Second Conference. First we published the Terzaghi Lectures in two volumes of the Conference Proceedings. To do this we had to charge a registration fee of $1.50. Second on Friday night there was a dinner in the Crystal Ball Room of the Driskill Hotel - the charge for the dinner was $1.25. The dinner was optional.

The Third Texas Conference was held on February 23rd and 24th, 1940 and again Dr. Tenzaghi gave lectures as follows: (1) "The Bulkhead Problem", (2) "Recent Developments in Sampling and Testing" and (3) "Experiences with Creek and slides in Stiff Clays". Proceeding of this Conference were published along with discussions by prominent engineers.

In the spring semester of 1941 we were able to have Dr. Karl Terzaghi as Distinguished Professor of Civil Engineering at The University of Texas. He had a large graduate class - some 90 students that semester as well as giving special weekly lectures to the Senior Civil Engineering students.

During that semester we held the Fourth Texas Conference with over 200 attending. Dr. Terzaghi gave two lectures at the Conference and other lectures were given by: C.A. Hogentogler, US Bureau of Public Roads; A.E. Cummings, Raymond Concrete Pile Co., Chicago; J. Neils Thompson, Texas Highway Dept., A.J. Moore, International Boundry Commission and Frank M. Van Auken, U.S. Engineer Office. Proceedings were published and a banquet held.

The Fifth Texas Conference was held February 6th and 7th, 1942 with papers by a number of distinguished engineers. Frank Van Auken of U. S. Engineer Office; Spencer Buchanan, Mississippi River Commisssion; G. Cadaval of Mexico; Dr. P.C. Rutledge, Purdue University, Frank H. Newnam, U S Engineer Office and Raymond Dawson, The University of Texas. At the Friday night banquet, J. Frank Dobie gave us some "Earthly Stories".

The Sixth Texas Conference was held August 13th and 14th, 1943 with another large group of engineers attending. Dr. Terzaghi gave two lectures and the following distinguished engineers appeared on the program. H.C. Carter, U.S. Engineer Office and The University of Texas Faculty Members as Follows: Dana Young, J. Neils Thompson and Phil M. Ferguson. No banquet was held but on Friday the ASCE student chapter held an informal reception and inspection of the Soil Mechanics Laboratory.

The Seventh Texas Conference was held in 1947. Again Dr. Terzaghi gave three lectures and other engineers gave papers. They were: W.E. Simpson, San Antonio; Lenoardo Zeevaert, Mexico City; A.E. Cummings, New York; and Raymond F. Dawson.

The Eight and final Texas Conference was held September 14th and 15th, 1956. This was a speciality conference dealing with off-shore structures. Dr. Terzaghi gave a very special lecture on Submarine Slope Failures. It and the other papers were important to designers and builders of off-shore oil structures. The authors were: Dr. H.N. Fisk, Houston; Bramlette McClelland, Houston; Hudson Matlock and Dr. E.A. Ripperger, The University of Texas; Dr. Philip C. Rutledtge, New York; Dr. Nathan M. Newmark, University of Illinois; and Dr. Lymon C. Reese, The University of Texas.

In the fall of 1937 we added Soil Mechanics to the Civil Engineering undergraduate program in the form of lectures and laboratory work. As the years advanced we added new undergraduate and graduate courses along with thesis and dissertations. I always encouraged the graduate students to select the younger faculty members to supervise their thesis or

dissertation in order to bring fresh young ideas into the research. Our teaching and research brought many outstanding young engineers into teaching, research and engineering practice.

In about 1940 the Texas Section of the American Society of Civil Engineers established a Soil Mechanics and Foundation Committee with Raymond Dawson as Chairman. This committee collected information on foundation problems and failures as well as other soil information. We had so many engineers wanting on our committee that some changes had to be made. Prior to that time the National American Society of Civil Engineers had set up a number of Technical Divisions and among them was the Soil Mechanics and Foundation Division. There was no limit to membership in the Technical Divisions. It occurred to me that we might set up such an organization at the local section level. In order not to confuse it with the National Division we called it the Local Section Group. At that time my friend Dr. Arthur Casagrande was Chairman of the National Division and I presented our plan to him. He liked the idea and had it approved by the National Board of Directors. This was the first local Technical group in the American Society of Civil Engineers. Now many local sections have technical groups in many areas. At the present time the Texas Section has thirteen technical groups in various fields of engineering.

I was elected a member of the Executive Committee of the ASCE Soil Mechanics and Foundation Engineering in 1952 but resigned in 1954 when I was elected a National Director of ASCE. My term as National Director was from 1954 to 1956. Virtually all of my effort as National Director was in the interest of the Texas Section.

During the summer of 1951 I taught Geotechnical Engineering at the Chulalongorn University in Bangkok, Thailand. The University of Texas had a contract through the United States State Dept. to improve the engineering dept at Chulalongkorn University and brought many Thai faculty and students to America for training as well as sending faculty to Bangkok. shortly after I returned, Dean Woolrich brought a "load" of material and placed it on my desk and said I was in charge of the project. My spirits wilted because I knew the project was in a "mess". He also

brought a new full-time secretary and she was a jewel - in no time she had the affairs in first class shape and kept them in that order throughout the end of the contract. That was one of the many times that a smart, clever secretary made me "look good" and I do not hesitate to give them credit.

During 1948 the Second International Conference on Soil Mechanics and Foundation Engineering was held in Rotterdam, Holland and the Third Conference was held in Zurich, Switzerland in 1953. I attended both conferences, - again at my own expense. The Seventh International Conference was in Mexico City in 1969. This was the date of my retirement from The University of Texas and some of my friends gave me plane tickets to attend this conference/

In 1936 the State of Texas erected a monument commemorating the victory at the Battle of San Jacinto 100 years earlier. The plans called for a monument 549 ft high - lower than the 555 ft. Washington monument since the Federal Government was supplying some of the building funds. The height depends on where you measure. At the time no mention was made of the base on which the monument rests. When completed it was 570 ft. high which at the time made it the tallest masonry structure in the world. I was able to consult with Mr. Robert J. Cummins, Engineer, Mr. Alfred C. Finn, Architect on the soil conditions and foundation design. The foundation is a concrete slab, 124 ft. square, 5 ft. thick at the edges and 15 ft thick at the center. The slab had to be a continuous pour and if anything went wrong it was to be taken out and a complete new start made. The contractor was Bellows Construction Co. and Mr. Warren C. Bellows was the president. Prior to construction I was able to test several soil samples and make settlement analysis. I was also able to arrange to install bench marks on the Battle Grounds but away from the Monument. During construction we installed 50 observation points in the base and keep settlement records on the structure.

During construction, and before the concrete was poured, I was taking some undisturbed soil samples from the final grade. I had on old work clothes and was very careful and deliberate in removing the

samples when Warren Bellows, watching me from above, thought I was one of his workmen. He rushed down into the excavation to "fire" me. He was a wonderful person and we all had a good laugh over my "firing"/

During construction and the first year thereafter, settlement readings were taken at short intervals - only a few weeks, between observations. Following that period the observations were made with lengthening intervals between readings. Actual settlements for about the first 8 post-construction years coincide remarkably with the predicted settlement. After that period the actual settlement was greater than predicted and continues to fall at a uniform rate of 1/4 inch per year. This may be considered as Secondary consolidation- something that has never been thoroughly investigated - it appears to continue at a uniform rate. However there are some slight indications that it may be slowing up a little. It will take two or three more decades of continued careful measurements to find out. Another factor may be our laboratory testing procedures. If we had completely controlled temperature conditions and more accurate deformation measurements perhaps the laboratory test would indicate the probable the extent of this secondary consolidation. While we predicted only slightly over 7 inches of settlement, the actual amount has been 12.3 inches - much of it resulting from the so-called secondary consolidation.

A major factor influencing the behavior of the Monument is the land surface subsidence in the area due to ground water withdrawals by industrial plants in the vicinity. Subsidence has lowered the ground surface several feet causing causing the concrete curb around the Reflecting Pool to sink below sea level. Also several roads leading to the Monument were below the water surface making it difficult to reach the structure.

Our Bench Marks (five in number) were located 250 to 300 ft. from the Monument and consisted of pipes 26 ft. long in larger casings. It is amazing that this ground subsidence did not seriously alter the relative elevations of the bench marks and it did not cause any great differences in their elevations. From time to time the United States Coast and Godetic

Survey have included our Bench Marks in their surveys of this area and we feel confident that they are satisfactory but also subsided with the Monument.

The unusual thing is that we were measuring settlement in inches while the entire area was subsiding in feet. New laws have put an end to the ground water pumping so the subsidence will stop but secondary consolidation will continue.

When I retired in 1969, some of my friends presented me with a bound volume of "Letter From My Friends". A distinguished Texas Structural Engineer wrote:

"In the thinking of many of us, you have been considered as the Dr. Terzaghi of Texas. Your efforts in the soil field have accomplished as much as any one in Texas to promote the use of soil science in the design and building of engineering works. This has been done without the flamboyance and showmanship of the good Doctor. We think this is good".

Perhaps Dr. Terzaghi was flamboyant and used showmanship to emphasize the importance of his work but he was a keen thinker and tireless worker. My association with him was the highlight of my professional career.

Dr. Terzaghi loved Austin and the hill country to the west. It was always "can't we find another little hill to climb" or go for a "swim" at Barton Springs. In the spring of 1941 we attended an event at the Boy Scout Hut in Zilker Park. It was a lovely evening and Terzaghi admired the beautiful Colorado (of Texas) River. He remarked: "the Danube was never so blue." I am sure that he would be disappointed at the murky brown sewage that now exists in the rivers. During the University's Centennial of 1981 the College of Engineering received many endowed chairs, professorships, faculty fellowships and lectureships. These were all matched by the Board of Regents with money from the Permanent Fund. The Warren S. Bellows Construction Company gave several of these awards to the University. One of the matching Centennial Teaching Fellowships was named the Raymond F. Dawson Centennial Teaching Fellowship in

Engineering. I was most pleased to have this fellowship carry my name as the award goes to the younger faculty members who need encouragement to continue in teaching.

Before Wilda died in 1985 we agreed that we would establish a scholarship in our names in Civil Engineering with the understanding that it would be in the Geotechnical area if qualified students were available. Shortly after this she died and because of will probation and revising of the Trust the scholarship was not set up until April of 1986. It is known as the "Wilda and Raymond Dawson Endowed Presidential Scholarship in Civil Engineering". I am happy to report that it has been filled by an excellent student and I anticipate that will be so occupied in the future.

I have purposefully omitted the names of many faculty, students and friends who contributed to the success and enjoyment of this episode. I am fearful that I might inadvertently omit someone who contributed greatly to it. It has been a good life and I can never sufficiently thank my friends, students and secretaries for their contributions.

In 1969 when I retired from the University, my friends, associates and former students presented me with a bound volume of over seventy letters that I treasure highly. Although one knows that he is not the super person these letters claim, he enjoys reading them from time to time and to recall memories of events and friends included in these letters.

Some months ago a friend asked me "which is the outstanding letter of the entire volume?" I replied, "they all are and I cannot select any one over the others." The friend replied, "think it over." I again said there was no letter so outstanding that I could put it above the others. After much thought I did decide that one did linger in my memory long after the others. That letter was from my secretary. She worked with me every day and knew my faults, short-comings and many errors - in fact she had to cover all these items in order to make me "look good." There was no reason for her to say nice things about me because I was no longer her "boss". She was an outstanding secretary and I depended on her doing everything correctly. In the fall of 1968 when I had my cancer operation

followed by weeks and weeks of cobalt treatments, my associates taught my classes but my secretary was the graduate advisor. Each day she meet with the students, answered the mail and then about four o'clock came out to our house and went over everything with me, bringing letters and reports I needed to see and the next day answered the letters and told the graduate students the answers to their problems.

If I half-way "measured up" to her description of my qualifications then I feel that life was worth while. I am taking the liberty of adding a copy of her letter to this story.

May 2, 1969

Dear Professor Dawson:

Even though I don't completely understand the quality of your professional status and I can't commend you on all your years of contributions in the field of soil mechanics, I do want to express my feelings concerning you as an "ordinary, average person". I guess the highest compliment I can pay you (in my eyes) would be to say even with all of your formal eduction, "book learning", etc., you are one of the wisest, kindest and most considerate men I have had the pleasure of knowing. It has been a privilege to work with you these past four years and my biggest regret is that I didn't start sooner.

Needless to say, with your retirement, I am going to have to face up to certain realities. I know I'll never have another "boss" that will measure up to you and our excellent working conditions. No "important things first", and no leaving early to make up for a late arrival, and no beautiful camellias each spring. One of the thins I'll miss most is how important you always made me feel. Never once did I hesitate in asking a "stupid question" or try to hide my ignorance on any subject. This was because you were so patient in explaining things and even with your vast knowledge of everyday matters and all your technical knowledge, I never felt inferior. I know this trait of yours is one of the reasons you were such a top-knotch professor and graduate adviser. The students always felt that you were interested in them as an individual, which is truly remarkable quality that you have.

I now give you my sincere and heartfelt thanks for being able to work with you and learn so much. One thing for sure, I plan on stopping in for an occasional visit with you and Mrs. "D".

With love,

Pat