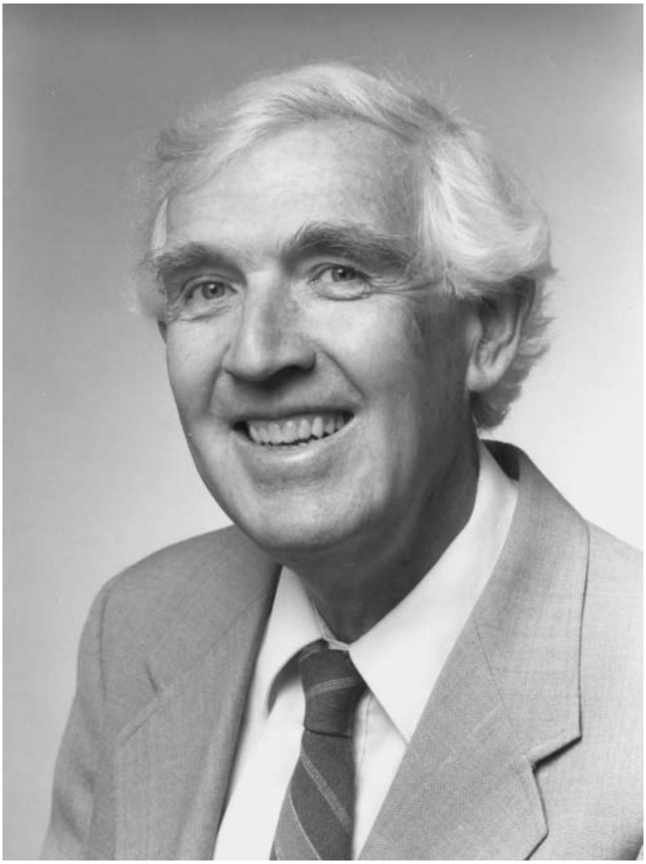

Ronald F. Scott

RONALD FRASER SCOTT

1929–2005

Elected in 1974

"For contributions to the theory and application of soil mechanics."

BY PAUL C. JENNINGS AND PAMELA J. SCOTT

RONALD FRASER SCOTT, Dotty and Dick Hayman Professor of Engineering, Emeritus, at the California Institute of Technology in Pasadena died on August 16, 2005, at the age of 76. He was elected to the National Academy of Engineering in 1974 for "contributions to the theory and application of soil mechanics."

An internationally recognized expert on the mechanics of soils, Ron worked on a wide range of problems, including the freezing and thawing of soils, the characteristics of lunar and Martian soils, the characteristics of ocean-bottom soils, soil liquefaction, the dynamics of landslides, and the mechanism of earthquake-caused sand blows. He pioneered the use of centrifuges in the United States for studying the behavior of soil structures, such as earthen dams, under both static and dynamic loading.

Ron was born in London, but grew up in Perth, Scotland, where, among other things, he dug potatoes during World War II when the men were all in the service. He earned a bachelor's degree in civil engineering from the University of Glasgow in 1951 and then came to the United States where he earned an Sc.D. in civil engineering (soil mechanics) from the Massachusetts Institute of Technology in 1955. After graduation, he worked for the U.S. Army Corps of Engineers on the construction of pavements on permafrost in Greenland and for the engineering consulting firm of Racey, McCallum and Associates of Toronto.

Ron met his wife, Pamela Wilkinson, a flight attendant for American Airlines from Bedfordshire, England, on his way to Caltech for an interview. They were married on May 28, 1959, and subsequently had three sons, Ron and twins Craig and Grant, and then nine grandchildren. Ron rose through the academic ranks at Caltech to full professor in 1967 and became Hayman Professor in 1987. In 1998, he became professor emeritus.

Ron had a deep understanding of theoretical aspects of the mechanics of solids, and his research was characterized by thorough study of underlying scientific issues. He was always motivated, however, by practical problems and was adept at showing how his research results could be useful in engineering practice. He also had a knack for explaining complicated concepts in soil mechanics to the general public.

In the 1960s, Ron became involved in evaluating the properties of lunar soil to determine if manned spacecraft could land safely on the lunar surface. At the time, there was wide speculation; some thought the Moon was covered with a thick layer of fine powder that would not support a landing vehicle or a man on the surface; others believed that the surface was quite firm. In 1963, Ron proposed that NASA include an experiment on soil mechanics on a Surveyor spacecraft. The proposal was accepted, and Ron became the principal investigator.

The experiment was first flown in 1967 on Surveyor III. The surface sampler, as it was called, resembled a small backhoe shovel mounted on an extensible trellis. After the successful landing, Ron wrote that "for the next two weeks, Floyd [JPL engineer Floyd Roberson] and I happily and sleeplessly played with the lunar soil on the inside surface of a 650-foot diameter crater."

Many readers will remember the pictures of the "scoop" digging into the lunar soil relayed from the Moon. Although it looked like a toy, the scoop was, in fact, an ingeniously designed instrument that made significant measurements of the strength, cohesion, and density of lunar soil. It also provided information about the homogeneity of the soil and variations in soil properties with depth. Because the sampler could exert pressure when the scoop door was closed, it was possible to use it to distinguish between rocks and clods.

From these tests, Ron concluded that the lunar soil at the site was fine-grained, with a small amount of cohesion, an internal angle of friction of 35 degrees—properties similar to those of damp terrestrial sand—and that it was safe to walk on. When Neil Armstrong stepped onto the surface of the Moon, his famous words, "That's one small step for a man, one giant leap for mankind," were followed by "I sink in about an eighth of an inch. I've left a footprint on the surface," words that confirmed Ron's conclusions.

This story has a postscript. In November 1969, Apollo 12 landed close to Surveyor III, and part of the mission of astronauts Conrad and Bean was to retrieve various parts of the Surveyor spacecraft. Although it had not been included in the plans, Conrad also retrieved the scoop and brought it back to earth. Upon learning this, Ron remarked, "If I had known I was going to see it again, I would have left the scoop completely packed with lunar soil." A similar scoop, also designed by Ron, was used on the Viking spacecraft in 1976 to investigate the properties of Martian soils.

In the 1970s, Ron became convinced that centrifuges should be used in the United States to advance knowledge of the dynamic properties of soils and soil structures, particularly when subjected to strong earthquake motions. Centrifuges had been used to study soils in the Soviet Union, but with the exception of P. B. Bucky at Columbia, who used them to study problems related to mining, they had not been used in the United States. A centrifuge is a valuable tool, Ron argued, because the mechanical properties of soils depend on the overburden pressure. For example, deeper soils, which are under more pressure than surface soils, have higher failure levels than the same kind of soil near the ground surface. Thus to test a 1/100 scale model of an earthen dam made of the same material as the full-scale prototype, the soil must be subjected to an effective gravity 100 times the gravity of the Earth.

In 1975, Ron convened a workshop at Caltech to bring the potential value of this method to the attention of U.S. researchers. The conference introduced the first research in the United States using centrifuges, and they are now widely used and acknowledged to be extremely valuable for studying soil mechanics. In his introduction to the workshop, Ron's famously dry sense of humor was on display in an illustrated history of the uses of centrifuges in science and engineering, chiefly in medicine. At the time, centrifuges were used for the treatment of the mentally ill, and a spinning platform had been patented for using centrifugal force to facilitate childbirth.

For Ron's first centrifuge research, he adapted a small centrifuge he had obtained from NASA for research on soil mechanics. Installed on the roof of a Caltech building, the machine had a 40-inch radius and could accommodate models whose largest dimensions were approximately one foot. In a series of experiments in the late 1970s and early 1980s, Ron and his coworkers—students, postdoctoral fellows, and engineers from industry—performed experiments on the performance of piles for offshore drilling structures, the behavior of anchors for the support of guyed offshore towers, dynamic pressures on retaining walls during earthquakes, the mechanics of fault rupture in rock and alluvium, and the earthquake behavior of foundations and footings.

These experiments were not easy to perform. The modeling requirements meant that time in the model had to run much faster than time in the prototype. For example, a 20 to 30 second earthquake accelerogram had to be compressed into 2 or 3 seconds of model excitation, and it had to be applied by a small shaker in a high-g environment in a bucket spinning many times a second within a closed cage. Data, typically strains and pressures, were extracted electronically through sliding contacts at the central shaft, and time-dependent displacements were recovered through the use of mirrors and high-speed photography.

The results were very important in advancing the state of soil mechanics. Because large earthen structures could not be subjected to failure-level stresses, the results of the centrifuge tests provided the best available experimental confirmation of engineering calculations and design methods.

Another of Ron's interests was landslides and dam failures. He was a consultant on the Baldwin Hills Dam failure in Los Angeles in 1963, and he studied the disastrous Bluebird Canyon landslide in Laguna Beach in 1978. By studying a small landslide in Los Angeles, which moved slow enough to be analyzed, he was able to make measurements of the motion on the slide plane and document the observed pulse-like character of the sliding.

Ron received many awards for his contributions to the advancement of soil mechanics, among them the Huber Research Prize, the Norman Medal, and the Thomas A. Middlebrook Award from the American Society of Civil Engineers (ASCE) and the Newcomb Cleveland Award from the American Association for the Advancement of Science. He was the ASCE Terzaghi Lecturer in 1983 and the British Geotechnical Society Rankine Lecturer in 1987. He was also a Guggenheim Fellow and a Churchill Fellow at Cambridge University, England. In 1995 he received an Honorary Doctorate of Engineering from his alma mater, the University of Glasgow. Ron was the author of four books, over 250 papers, and holds four United States patents.

He leaves behind his wife Pamela J. Scott, his sons Grant Fraser Scott, Craig Alistair Scott, Roderick Jonathan Scott, and nine grandchildren.

BY PAMELA J. SCOTT
SUBMITTED BY THE NAE HOME SECRETARY

Ron was a kind, thoughtful and loving husband and father to our three sons. Although he was extremely busy with his work at Caltech and his involvement with the space program in the 1960s, he always made time to spend with his three small boys.

Ron was a very keen and competent golfer. He taught the boys golf at an early age, and Grant especially enjoyed playing with his father, with the junior PGA and on his high school team. I also took up the sport although I preferred tennis. We made a pact shortly after our marriage that I would learn to play golf if he would take tennis lessons. Consequently, throughout the years when the boys were home, we would all play tennis and golf together.

Ron was proud of their athletic prowess and would enthusiastically watch their high school games: Grant tennis, soccer, and golf, and Craig and Rod soccer, swimming, and water polo. Craig and Rod were Eagle Scouts with the honor of carrying the banner in the 1979 Rose Bowl Parade when Jimmy Stewart was the Grand Marshal. We all loved to hike and we spent many happy hours in the local mountains and national parks and also hiked and camped in Europe and Hawaii.

We all love to read and it was Ron who instilled a love of books and reading in our lives. To quote Grant's remarks at the memorial gathering, "My father cultivated a love of literature and was an omnivorous reader . . . he loved words especially puns where there was slippage in the slope of language, perhaps a kind of liquefaction where two letters supporting a dam of meaning gave way or there was semantic friction or failure. He liked to see words collapse into other words and watch as a seismic shift altered the landscape of a sentence."

Ron was not only a husband and father but our best friend, always approachable with advice, guidance, and a marvelous sense of humor.

Acknowledgment

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