Obituary: Professor Kenji Ishihara (1934–2025)

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Professor Kenji Ishihara, a former President of the ISSMGE and the Japanese Geotechnical Society (JGS), passed away suddenly due to a heart attack at the age of 91, on December 26, 2025. Only days earlier, he had been actively participating in professional activities, including the presentation ceremony for the ISSMGE International Lifetime Achievement Medal (ILAM) held at the JGS headquarter on December 15 (the above photograph), followed by a dinner with colleagues on the next day. We honor his lifelong achievements and offer our deepest condolences.

Professor Ishihara was born in Chiba Prefecture near Tokyo on April 16, 1934. At the age of four, he moved to Shimane Prefecture, western Japan, following his father, Morie Ishihara,

who was a technical official at the Livestock Research Station and was assigned to a newly established research facility for the improvement of Japanese Black cattle. Prof. Ishihara remained there until graduating from Ota High School. During his high school years, he received exceptional daily guidance in mathematics for two years from a teacher named Jonsen Morii, which significantly refined his talents.

In 1953, he entered the University of Tokyo. During this period, he demonstrated a characteristic eagerness to learn through personal encounters, such as visiting Shumei Okawa who was a political philosopher and had a strong influence on the Japanese Government before WW2. In his second year, he advanced to the Department of Civil Engineering. He was captivated by Professor Takeo Mogami's lectures on applied mechanics for their clarity and interest, which inspired him to pursue research in this field. He was also drawn to the Applied Mechanics textbook by Professor Shunzo Okamoto. Nevertheless, as the research laboratories for applied mechanics and hydraulics were already populated by many distinguished seniors, he anticipated that he might "not make much headway" there. (Note: Quotations in double brackets represent Prof. Ishihara's own later recollections.) Consequently, along with his classmate and "ambitious, high-spirited youth" the late Prof. Toshinobu Akagi (formerly at Toyo University), he decided to join the Mogami Laboratory and pursue a career in soil mechanics.

In those days, soil mechanics primarily focused on consolidation theory and detailed discussions on shear behavior under drained or undrained conditions had not yet emerged. Prof. Ishihara recalled decades later that Prof. Mogami's lectures and textbooks on soil mechanics were "tedious" at that time. However, the late 1950s marked a turning point where civil engineering began transitioning from purely theoretical approach towards understanding

and predicting the behavior of actual ground through laboratory experiments, field investigations, and computational modeling. Professor Ishihara became a key figure in this transformation.

His undergraduate thesis theme at the Mogami Laboratory addressed clay ground improvement, including a proposal for vibroflotation research. However, he ultimately worked on "inducing pore water into sand piles by heating the surrounding clay ground with thermal wires buried within the piles". Having spent his time "idling" until mid-October of his senior year (from April to March), he finally began his model experiments after receiving a "thunderous scolding" from Prof. Mogami. Contrary to his initial expectations, the results showed that the clay was hardened by heat and actually obstructed the flow of pore water, thereby delaying consolidation. This is an anecdote that younger researchers, who might assume great professors always succeed, should take to heart.

During his Master’s program, after spending the first eight months inactive due to health reasons, he studied intensely. He submitted his Master’s thesis on the numerical calculation of stress distribution in two-layered ground using elasticity theory, comparing the results with measurements in model experiments. Even in the era dominated by theory, the seeds of his lifelong commitment to positivism were evident.

Continuing to his doctoral studies, he became immersed in slope stability analysis using plasticity theory. He learned Russian language to read literatures authored by Sergey Sergeyevich Golushkevich of the Saint-Petersburg State Polytechnical University, and spent a year and a half on attempting to derive rigorous solutions. Ultimately concluding that the problem could not be analytically solved, he turned his focus, in a state of "heartbreak", to

deriving viscoelastic solutions for two-layered subsurface soil systems. He was awarded his doctorate for his English dissertation titled "Research on two-layered subsurface soil systems based on the theory of viscoelasticity". As a subsequent development, he also derived a theoretical solution demonstrating that stress distribution in the ground changes according to the processes of excavation or embankment, meaning that no unique solution exists[1)]. This work was a purely mathematical and theoretical achievement, proving Professor Ishihara's high ability in that field as well.

The following summarizes Professor Ishihara's professional career in academia:

- August 1961 – December 1963: Research Assistant, The University of Tokyo
- March 1963: Awarded Doctor of Engineering
- December 1963 – May 1966: Lecturer, The University of Tokyo
- May 1966 – June 1977: Associate Professor, The University of Tokyo
- September 1966 – September 1967: Visiting Scholar at the University of Illinois (under Professor R. B. Peck)
- June 1977 – April 1995: Professor, The University of Tokyo (Professor Emeritus as of May 1995)
- April 1995 – March 2001: Professor, Tokyo University of Science
- April 2001 – December 2025: Special Appointment Professor / Institutional Professor, Chuo University

After his promotion to Lecturer, while exploring new research themes, Professor Ishihara became deeply interested in the poroelasticity theory developed by M. A. Biot[2)], a Belgian-American applied physicist renowned in aeronautical engineering and structural geology. His work in this area led to a significant achievement: expressing the Poisson ratio, ν, in undrained wave propagation as a function of the shear stiffness of the solid skeleton, μ,

porosity, *n*, and the bulk compressibility of the pore fluid, C_l[3];

$$\nu = \frac{1}{2}(1 - \mu n C_l)$$

However, he realized that the work of his predecessors was already quite comprehensive, and concluded that "further pursuit would not yield any novel conclusions". This conclusion prompted him to change his research direction.

The fundamental shift in Professor Ishihara's research style, from static to dynamic problems, was triggered by the Niigata Earthquake in June 1964. While it may seem that geotechnical earthquake engineering modernized overnight due to this disaster, the seeds of change had been sown actually a few years prior. At that time, a committee on seismic design methodology within the Japanese Society of Soil Mechanics and Foundation Engineering (now JGS) had identified a severe lack of systematic knowledge regarding the dynamic properties of soil. In response, a new committee on the dynamic properties of soil was established. After much laborious effort, the committee published a report titled 'Dynamic Properties of Soil and Its Applications' in January 1965. This was a pioneering work in the field of geotechnical earthquake engineering. As a young member of the committee, Professor Ishihara co-authored the first chapter, 'Properties of Soil During Vibration', and the second chapter, 'Mechanical Properties of Soil Subjected to Cyclic Stress', alongside Professor Mogami. Both chapters were state-of-the-art reports summarizing contemporary research interests. Someone may wonder why this important publication did not touch upon the Niigata earthquake and soil liquefaction despite its publication six months after. This is because the drafts were due in March 1964 and the issues on the earthquake were given to future publications.

In the tradition of earthquake engineering, approaches such as Toshikata Sano's seismic coefficient method[4), 5)] and the Mononobe-Okabe seismic (active) earth pressure theory[6), 7)] had existed since 1920s, but they were primarily theoretical and focused on strength; failure vs. non-failure. The 1965 report marked a shift towards experimental verification, introducing research where soil specimens were cyclically sheared to measure their strength and residual deformation. Interestingly, the report did not yet mention the large deformations caused by liquefaction of saturated loose sand, a phenomenon that would later define the field. Little attention was paid to the degree of saturation or extents of drained or undrained condition, which is in clear contrast with the studies in later times. Even the term 'liquefaction' was used differently at the time, referring to the way sand particles moved in a model embankment during vibration resembling liquid convection.

Following the Niigata Earthquake, the Japanese Government requested the University of Tokyo to conduct urgent research on liquefaction of the present sense (large deformation and failure of water-saturated loose sand during earthquakes). This led to model experiments using a 4-meter-long rigid soil box to measure the vibration of sand deposits resting on inclined bedrock. In his subsequent paper, Professor Ishihara discussed the variation of surface response and even the similitude law between actual ground and a *1g* model ground[8)], marking the true beginning of his lifelong research in soil dynamics.

In 1966, Professor Ishihara got a chance to study at the University of Illinois at Urbana-Champaign, USA, for one year, supported by the Fulbright Scholarship and the university funding. He was immersed in a world-class environment under the mentorship of the renowned Professor R. B. Peck and Department Head Professor N. M. Newmark, along with

other eminent figures such as Professors Deer, Hendron, Thornburn, Ireland and many others. This experience paved the way for his future global prominence. During the Cold War era, research on ground behavior under blast loading was being headed by Prof. Newmark's group. Although Professor Ishihara was not directly involved as he belonged to the Peck group, his interest in soil dynamics intensified. However, he initially struggled with English conversation. He recalled "attending an English conversation department for foreigners, where he practiced pronunciation using musical scores to master intonation, which significantly improved his speaking skills". He also felt a sense of cultural clash, noting that the Japanese research style of verifying theory through experiment was not always prioritized in the West. He reflected with characteristic humility, "I concluded my stay without conducting any joint research... I felt I was the most useless foreign researcher despite all the support I received".

Upon his return a year later, the university entered a period of turmoil due to student protests, leading to the collective resignation of the university administration, including his mentor, Dean of Engineering Takeo Mogami. Once the unrest settled several years later, research into liquefaction through experimental methods and field investigation began in earnest with the operation of a hydraulically-controlled cyclic triaxial shear apparatus in 1970 and the introduction of a large-scale shaking table. According to his own records, Professor Ishihara published 291 English papers throughout his career, covering liquefaction, slope failure, and pile foundations.

Following the development of the cyclic triaxial apparatus, various sophisticated devices were brought into operation: torsional shear apparatus which, due to early budget constraints, reportedly required 'masterful technique' to manually apply constant stress amplitudes and

initially ran tests on a solid cylindrical specimen until later a hollow cylindrical specimen was introduced, an independent three-principal-stress control shear apparatus, and a two-directional simple shear apparatus. These advancements opened a new world of research into the shear behavior of sand, distinct from the clay-oriented European style of soil mechanics. While Professor Ishihara's core strength lay in analytical methods based on applied mechanics and mathematics, from this period onward, mathematical approaches took a backseat to experimental methods based on laboratory tests and field investigations. This shift likely stemmed from a fundamental policy; to ensure results that are clear and convincing enough for the capability development of research students, a philosophy influenced by the clarity he admired in Professor Mogami's lectures.

Professor Ishihara's contributions to liquefaction and soil dynamics are vast. Some of the most notable achievements that deserve our attention are experimental research on undrained shear of sand and liquefaction including the proposal of stress ratio as the yield function in plasticity theory and the naming of the 'Phase Transformation Line' where dilatancy switches from contractive to expansive[9], practical methods for estimating liquefaction resistance of sand[10], soil-mechanic factors affecting liquefaction potential such as overconsolidation[11] and the *K*o value[12], laboratory liquefaction tests on undisturbed sand samples[13], effects of irregular loading such as actual earthquake loading[14, 15], multi-directional (north-south and east-west seismic loading) simultaneous shear loading[16], evidence of excess pore water pressure rise recorded in the field during real earthquakes[17, 18], sand behavior under independent control of three principal stresses[19], sand behavior undergoing rotation of principal stress axes[20, 21, 22, 23], steady state in which deformation develops unlimitedly while shear stress and volume maintained constant[24], prediction of liquefaction-induced settlement of sandy ground[25, 26], assessment of residual deformation of

earth structures induced by seismic loading[27], and influence of fines content on the cyclic shear strength of sand[28, 29]. All the studies were clear and easy for everybody to understand and apply to practice.

Professor Ishihara was a dedicated field researcher, investigating damage from numerous domestic (inside Japan) earthquakes, including Niigata (1964) [30, 31], Izu-Oshima Kinkai (1978)[32], Miyagiken-Oki (1978)[33], Nagano-ken Seibu (1984)[34], Hyogo-ken Nanbu (Kobe) (1995) [35, 36, 37], Tottori-ken Seibu (2000)[38], Miyagi-ken Oki (2003)[39], Niigata-Chuetsu (2004)[40] and the Great Tohoku Earthquake (2011)[41]. Leveraging his extensive international network, he also led or participated in damage investigations for major global seismic events, such as in Romania (Vrancea earthquake, 1977)[42], Ecuador (1987)[43], Armenia (Spitak, 1988)[44], Soviet Tajikistan (1989)[45], Iran (Manjil, 1990)[46], Philippines (Luzon, 1990)[47], Turkey (Kocaeli, 1999)[48, 49] and Indonesia (Palu in Sulawesi, 2018; report under preparation).

A notable practical contribution from these field studies was his empirical formula regarding the relationship between the thickness of a non-liquefiable surface layer (H_1) and that of a deeper liquefiable layer (H_2)[50]. This provided a valuable framework for assessing liquefaction risk in residential areas where funds of private house owners are limited for conservative and extensive ground improvement and allowed the owners to accept deep liquefaction if the surface soil is thick enough. Note that this empirical formula was built upon the original work of Professor Akie Asada during the 1983 Nihonkai-Chubu earthquake[51].

Beyond his research, Professor Ishihara played a pivotal role in the international geotechnical community. He served as the President of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) from 1997 to 2001. During his tenure, he resolved long-

standing challenges, including;

1. Inter-Society Collaboration: Fostering cooperation with sister societies, the International Society for Rock Mechanics (ISRM) and the International Association for Engineering Geology and the Environment (IAEG), culminating in the GeoEng2000 conference in Melbourne,
2. Secretariat Transition: Successfully managing the transition of the ISSMGE Secretary General after his marvelous 18-year term and introducing another marvelous person, Prof. Neil Taylor.

He also founded Technical Committee TC4 (now TC203) on Earthquake Geotechnical Engineering, which became the mother body for major international conferences and the prestigious 'Ishihara Lecture'. It also published a guideline for microzonation from the perspective of hazard risk assessment[52)].

Professor Ishihara's research findings were integrated into various Japanese design standards, contributing significantly to the safety of society. Internationally, he served as an advisor for projects led by UNESCO, the World Bank and JICA, and also participated in forensic investigations into accidents during underground construction[53)].

In recognition of these immense contributions, he was bestowed with numerous honors, including:

- The Japan Academy Prize
- The Order of the Sacred Treasure, Gold Rays with Neck Ribbon
- Terzaghi Orator (ISSMGE) and Rankine Lecturer (UK)
- The H.B. Seed Medal (ASCE)
- Foreign Member of the National Academy of Engineering (USA)

- Burmister Lecturer (Columbia University)
- The ISSMGE Individual Lifetime Achievement Medal (ILAM), which marked the final crowning achievement of his career.

Professor Ishihara nurtured countless engineers and researchers. His method was not the modern type of constant monitoring; rather, it was a philosophy of a Zen term for perfect timing that is described as ‘only when the chick taps the shell from the inside does the mother bird peck from the outside, ensuring the perfect moment for birth’. He provided the next hint or step only when the student had reached the level of further research stage. His students often felt they had achieved their goals through their own hard work, which instilled in them the confidence to excel globally. His influence expanded worldwide through his textbooks, such as *Soil Behaviour in Earthquake Geotechnics* (1996) together with *Introduction to Soil Dynamics* (1976 written in Japanese), *Soil Mechanics* (1988 in Japanese) and *Subsoil Liquefaction* (2017 in Japanese). He also played chief roles since 1983 in the international graduate program of the Civil Engineering Department at the University of Tokyo.

On a personal note, Professor Ishihara maintained a strict lifestyle to preserve his health. Though reportedly sturdier in his youth, he later practiced rigorous self-discipline, such as refraining from eating after 8:00 PM, which allowed him to remain active at the forefront of the field until the age of 91.

His passing coincides with a poignant sense of a departing era. His long-time friend of over 50 years, Professor W.D. Liam Finn (University of British Columbia, Canada), passed away just two days before him, and another close colleague from TC4, Professor Shamsher Prakash (India), also passed away on December 2. It feels like a profound destiny that these

giants of the field have embarked on their final journey together.

Professor Kenji Ishihara's lifelong devotion to the advancement of geotechnical and civil engineering will be remembered by the global community. We honor his memory and offer our deepest gratitude for his support and leadership.

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