Dr Kiyoshi Muto (1903–1989)

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Fig. 1: Dr Kiyoshi Muto (c. 1985)
(courlesy: Kobort Research Complex)

Another Week Has Passed

It was Saturday, March 11, 1989. This week had been another busy week for Dr Kiyoshi Muto (*Fig. 1*). He attended the Muto Institute of Structural Mechanics every day where at the age of 86 he continued to serve as Director and was active in research and design analysis activities. His recent enjoyment was to go to the Shinjuku area of Tokyo to look at the new city skyline swarming with skyscrapers, all designed under his guidance, and to watch the site of his last contribution, Tokyo City Hall, which had just completed its design stage, and the construction was about to start (*Fig. 2*). Towards evening he visited his wife Yoshiko Muto in the Miyairi Hospital, and as usual he spent several hours together with her. Yoshiko, the first daughter of his advisor Professor Riki Sano, married him in 1929, and was blessed with one son and two daughters. They celebrated their Golden Wedding Anniversary in 1979, but Yoshiko was recently suffering from liver cancer. At home, after a nightcap of Scotch whisky he went to bed – in which he never woke up again.

Imperial Metropolis Collapsed

Muto would have dreamed of past, present and future of earthquake resistant building structures to which he devoted his whole life. His first encounter with an earthquake dated back to September 1 of 1923. Born on January 29, 1903, as a son of Yoshitaro and Tsuru at Toride, Ibaraki Prefecture, Muto lost his parents while he was an elementary school pupil, and after spending high school days in Sendai where his elder brother Masao was working as a surgeon in the Medical School of Tohoku University, he entered the Department of Architecture at the University of Tokyo, in 1922. Being a science-oriented student, the study of art in architecture was not attractive to him. During a diversion journey he was staying at the Asamushi Spa in Aomori Prefecture on September 1, 1923, and was surprised by the news of the disastrous Kanto Earthquake that struck the Tokyo area. Quickly returning to the Ueno station, all he saw was a miserably shattered and burned Imperial Metropolis of Tokyo. This horrifying experience undoubtedly took root in Muto as the impetus for his passion to earthquake resistant construction.

Statical Seismic Design

Since then, over 65 years of work – Muto's contribution was vastly abundant. His pre-eminent achievement had been produced during not one, but two, distinguished careers. The first one was academic at the University of Tokyo for almost 40 years. The second career was practical at Kajima Corporation which he commenced as an Executive Vice-President in the year of his retirement from the University of Tokyo.

Shifting his major study to structural engineering in response to the Kanto Earthquake experience, Muto graduated from the University of Tokyo in 1925, and was immediately appointed to Lecturer, to Assistant Professor in 1927, awarded Dr of Engineering in 1931, and after two years of study abroad at the Berlin Institute of Technology he was appointed to Professor of Structural Engineering in 1935. His major research themes in those days were stress and deformation analyses of building frames subjected to lateral loads, and their vibration analysis. The world famous D-method, stress analysis of frames under horizontal loading using lateral load distribution factors, was the result of these studies. The seismic coefficient for earthquake resistant design, advocated by his father-in-law Professor Sano, had been incorporated into Urban Building Law in 1924 reflecting the Kanto Earthquake experience, but its use could not prevail without a practical hand calculation method of analysis for every structural engineer. Muto's D-method answered to this demand, and was adopted into the Calculation Standard of the Architectural Institute of Japan in 1933. Its popular use for general build-

Fig. 2: Tokyo skyline with high-rise buildings in Shinjuku (1993)
(courtesy: Kajima Corporation)

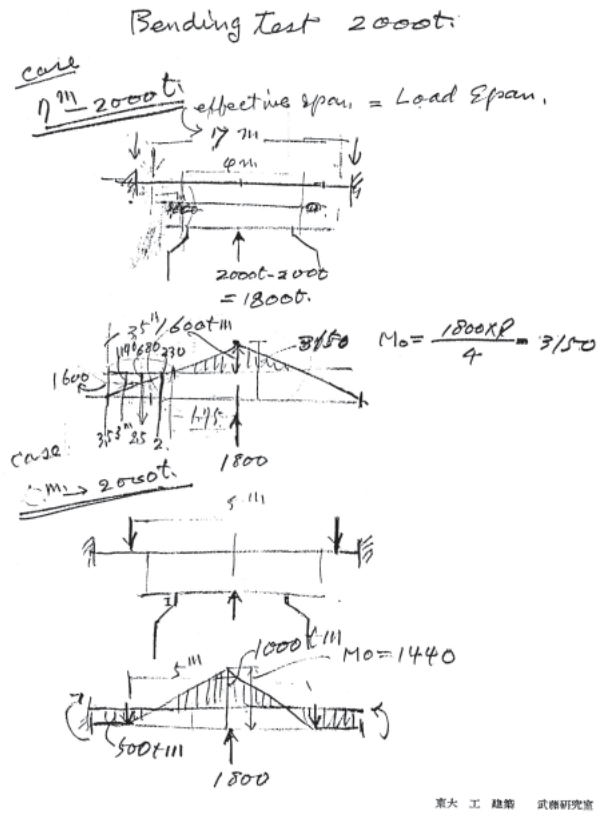

Fig. 3: A sketch during development of 2000 ton testing machine (1958)
(courtesy: Prof. Tsuneo Okada)

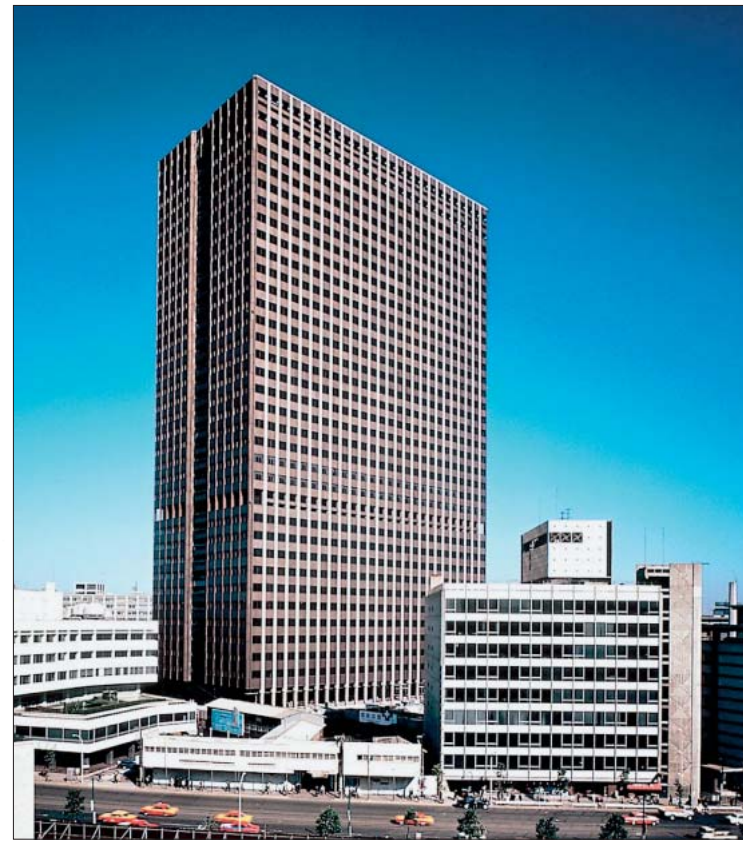

Fig. 4: Kasumigaseki Building, the first skyscraper in Japan (1968)
(courtesy: Kajima Corporation)

ings, in Japan as well as overseas countries, saved innumerable buildings from earthquake disasters for more than half a century until the arrival of the computer age.

Dynamical Seismic Design

Muto was firmly convinced, through his early study of structural vibration and study on blast resistant design during World War II, that earthquake resistant design of structures, particularly of high-rise buildings, would have to be based on their dynamic behavior in the elasto-plastic range. Based upon his foresight for the need of three elements, i.e. earthquake ground motion records, load-deformation relationship of structures and structural elements, and nonlinear earthquake response analysis method, he endeavored to develop, and installed in the University of Tokyo, a strong motion accelerograph SMAC (1952), a large-scale structural testing machine (1959, *Fig. 3*), and an analog computer SERAC (1961). He himself took the office of Dean of Engineering in 1960, and retired from the University in 1963, but these up-to-date research facilities supported the study of his followers for several decades, contributing to the recognition of Japan as an international leader in earthquake engineering. In 1960 the Second World Conference for Earthquake Engineering was held in Tokyo under Muto's chairmanship, and in 1963 he was installed as the first President of the newly organized International Association of Earthquake Engineering.

Executive of a Large Construction Company

Upon his retirement from the University of Tokyo in 1963, Muto was received by Kajima Corporation as an Executive Vice-President. Kajima was founded in 1840, and is today one of the largest general contracting firms in Japan with more than 7000 technical personnel. As Kajima was exploring the project of Mitsui Real Estate Co. to construct the first skyscraper in Japan at Kasumigaseki, Tokyo (*Fig. 4*), his entry to the company was an ideal setting to realize his long-cherished idea of dynamic design. The building was 36-stories high, and its design and construction in Japan, where most buildings were lower than 10 stories then, encountered a chain of technical, practical, as well as legal and administrative, difficulties. With all his might, he worked hard in leading the whole project group. In particular, he developed a large-scale computer program for time-history seismic response analysis of an elaborate elasto-plastic model of a structure, on the basis of his study at the University of Tokyo. A special seismic wall, called a slit wall, was one of his inventions for this project, which was utilized to control vibrations of the building under small earthquakes or strong winds, and to absorb vibration energy under strong earthquakes. Thus it was a predecessor of structural control devices, widely used in contemporary seismic design. Kajima continued to design and construct many skyscrapers under his guidance, completely changing the skyline of cities in Japan.

Muto Institute of Structural Mechanics

In 1969 he established a corporation called Muto Institute of Structural Mechanics, and in 1977 he stepped down from Vice-President of Kajima Corporation to concentrate on the directorship of the Institute. The business of the Institute consisted of seismic analysis and design of various special structures including high-rise buildings and nuclear power facilities, not necessarily related to the business of Kajima Corporation. Such a wide contribution to

public facilities was deemed worthy of Muto who came from a national university, and the work at the Institute was, though very hard and busy, quite comfortable and substantial for him.

Occasionally he might have recollected countless honors given to him for his brilliant contribution to the public, in Japan as well as overseas: Imperial Prize from the National Academy of Japan (1964), Commendation by the Minister of State for Science and Technology (1968), Medal with Purple Ribbon (1968), Member of National Academy of Japan (1975), IABSE International Award of Merit in Structural Engineering (1976), Designated Lecturer at the New Year's First Lecture to His Majesty Emperor (1977), Foreign Associate of the USA National Academy of Engineering (1978), Person of Cultural Merits (1979), and Order of Culture (1983).

Sixty-six Years since Kanto Earthquake

Japan has changed. Countless buildings line up along every street, all designed against earthquake forces using Muto's D-method, and skyscrapers soar up here and there, all designed against earthquake ground motions using Muto's dynamic analysis method. Such a wide spread of seismic design was, of course, the result of the endeavors of the many people involved, but Muto had always lead people in the development and execution of new technology. At the same time, he liked to consult with authorities in each field. Ms. Mitsuko Morinaga, his second daughter, lately recollected in her address at an alumni meeting, that her father did not look like a scholar, aloof and distant, but always in warm and affectionate contact with many collaborators, with full power of action as if fed by the energy of Mother Earth [3].

A nightcap of Scotch whisky with reminiscences of 86 years of life might have been a little excessive for him. Before dawn of March 12, 1989, Dr Kiyoshi Muto passed away due to heart failure in his home at Kamiochiai, Shinjuku, Tokyo. Funeral services were held on March 16 and 17 presided by Yoshiko, his widow, despite her anxious condition. His Majesty Emperor conferred on him a posthumous honor of Grand Condon of the Order of the Sacred Treasure. It was sad news for all who knew the couple, that Yoshiko followed her beloved husband to heaven on April 11, 1989, just 30 days later.

Acknowledgment

This article was compiled with the help of Dr Tadashi Sugano, ex-staff of Muto Institute, and was reviewed by Dr Hiroo Kanayama, Kobori Research Complex, Kajima Corporation.

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