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43-19

Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities

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PUBLISHED BY THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Library of Congress Cataloging-in-Publication Data

Names: American Society of Civil Engineers, author.
Title: ASCE standard, ASCE/SEI, 43-19 : seismic design criteria for structures, systems, and components in nuclear facilities / American Society of Civil Engineers.
Other titles: Seismic design criteria for structures, systems, and components in nuclear facilities
Description: Reston, Virginia : American Society of Civil Engineers, [2019] | Includes bibliographical references and index. | Summary: "Standard ASCE/SEI 43-19 provides stringent criteria to ensure that nuclear facilities are designed to withstand the effects of earthquake ground shaking"– Provided by publisher.
Identifiers: LCCN 2019054308 | ISBN 9780784415405 (paperback) | ISBN 9780784482407 (pdf)
Subjects: LCSH: Nuclear facilities–Protection–Standards–United States. | Nuclear facilities–Earthquake effects. | Earthquake resistant design–Standards–United States.
Classification: LCC TK9152.163 .A45 2019 | DDC 621.48/32–dc23
LC record available at https://lccn.loc.gov/2019054308

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/bookstore | ascelibrary.org

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Errata: **Errata, if any, can be found at http://dx.doi.org/10.1061/9780784415405**

ISBN 978-0-7844-1540-5 (print)
ISBN 978-0-7844-8240-7 (PDF)
Manufactured in the United States of America.

25 24 23 22 21 20 19 1 2 3 4 5

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Robert P. Kennedy, Ph.D., P.E., NAE
April 2, 1939–December 30, 2018

ASCE 43-19 is dedicated to Dr. Robert (Bob) Phillip Kennedy, a leader in the global nuclear energy industry for more than 40 years, with seminal contributions in civil and structural engineering, and probabilistic risk assessment.

Bob enrolled at Stanford University in 1957 where he graduated 10 years later with three degrees: Bachelor of Science (1960), Master of Science (1961), and Doctor of Philosophy (1967). His undergraduate studies were supported in part by a Holmes and Narver scholarship and he worked summers for this consultancy in Los Angeles. A keen athlete, he was on the swimming and water polo teams through graduate school. He graduated Phi Beta Kappa. He continued his studies at Stanford on a graduate fellowship from the US Department of Defense under the direction of Professor Jack Benjamin. While a graduate student, Bob cotaught a class on blast-resistant design with his Stanford classmate and fellow Benjamin advisee, the late C. Allin Cornell—the start of a lifelong collaboration between two of the most productive, respected engineers of their generation.

In May 1964, before finishing his Ph.D., Bob joined the US Army Corps of Engineers. He went to Ft. Belvoir in Virginia, where, after basic training, he was placed in charge of engineering courses for officers-in-training. In August 1965, he volunteered to move to Okinawa, Japan, to work on the design and construction of the Cam Rahn Bay logistics facility for the US Navy, an experience he described as unique and invaluable but one that gave him no time to complete his dissertation. Bob joined Holmes and Narver in Los Angeles in May 1966, after being discharged from the Corps, working there for two years. He filed his Ph.D. dissertation, "A statistical analysis of the shear strength of reinforced concrete beams" in April 1967. He relocated to the Holmes and Narver office in Las Vegas for two years to support work related to underground nuclear detonations at the Nevada Test Site. He left Holmes and Narver in 1977 to start the Southern California office of the Engineering Decision and Analysis Company (EDAC). He left EDAC in 1980 and established Structural Mechanics Associates (SMA) with a group of like-minded engineers. Bob preferred technical work to managing a multi-office engineering consultancy and SMA was sold in 1984. He provided independent engineering consultation at RPK Structural Mechanics Consulting, Inc. for the following 34 years.

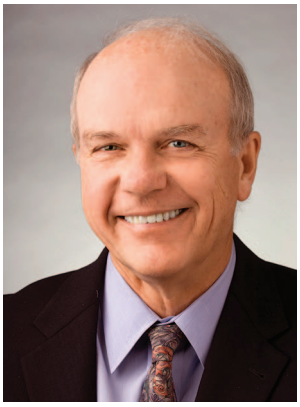
As an engineering consultant, Bob worked in many subject areas, mostly involving dynamic analysis and design and construction of mission-critical structures for the nuclear, defense, industrial, and petroleum industries. His work on the seismic ruggedness of nuclear facilities and the quantification of earthquake-related risk was fundamental, included the development of performance-based seismic design criteria for DOE Standard 1020 and ASCE 43; fragilities of structures, systems and components for use in seismic probabilistic risk and seismic margins assessments; methodologies for seismic walkdown reviews of critical facilities, including nuclear power plants; and teaching short courses on seismic probabilistic risk assessment around the world. He chaired the Senior Seismic Review and Advisory Panel from 1983 to 1992, providing guidance to the USNRC and power utilities on the seismic robustness of equipment in existing nuclear power plants. He served as lead author of a number of seminal reports in the 1980s and 1990s, which are still widely used today, related to seismic risk and margin assessments, including EPRI NP-6041 (August 1991), EPRI TR-103959 (April 1994), NUREG/CR-4334 (August 1985) and NUREG/CR-5270 (March 1989). Less well known but equally important technical contributions by Bob were in the domain of hardened structures and equipment, through consulting to the US Defense Threat Reduction Agency, US Defense Nuclear Agency, and other US government entities on a broad range of subjects, mostly related to extreme ground shock, pressures and temperatures generated by underground nuclear detonations.

Bob was an active member of the ASCE Committee on Dynamic Analysis of Nuclear Structures and its predecessor committee for nearly 40 years. He served as the first chair of the committee, which produced ASCE Standard 4-86. His pioneering work on performance-based seismic design criteria for safety-related nuclear facilities in the 1990s underpinned the technical basis for ASCE 43-05, enabling deterministic design procedures to be used to meet probabilistic goals. He made numerous other contributions to this standard and its analysis counterpart, ASCE 4, including characterization of ground shaking, modeling, analysis methodologies, soil–structure interaction, and seismic isolation. Bob improved this 2019 edition of ASCE 43 by revising the definition of earthquake input, replacing the design factor he introduced in ASCE 43-05 with a more broadly applicable scale factor. He also contributed to the writing of other codes and standards, including ACI 349, with an emphasis on design procedures for impactive and impulsive loadings on nuclear structures, and ASME standards for power piping.

Bob received many awards and honors over his career. He was elected to the US National Academy of Engineering in 1991 for "developing design procedures for civil and mechanical structures to resist seismic and other extreme loading conditions." Other awards included the 1992 ASCE Stephen Bechtel Energy Engineering Award and the 2015 ASCE LeVal Lund Award. Bob was a Fellow of the California Council of Science and Technology.

ASCE and the members of its ASCE DANS committee in particular, the global civil and structural engineering community, and all tasked with the design of energy-related facilities owe a debt of thanks to Bob Kennedy that cannot be repaid. Instead, and as a token of our deep appreciation and thanks, we dedicate this 2019 edition of ASCE 43 to our friend and colleague. Bob's absence from DANS committee discussions and deliberations is, and will be, sadly missed.

Stephen A. Short, P.E.
February 12, 1945–October 14, 2016
"It is nice to be important, but it is more important to be nice."



ASCE 43-19 is dedicated to Mr. Stephen Alan Short, a leader in the development of codes and standards for ASCE, a dedicated structural engineering professional, a loving husband and father, and a friend to many. The above quote from John Templeton circa 1912 was one of Steve's favorites and exemplified how he lived his life.

Steve received his Bachelor of Science and Master of Science degrees from the University of California, Berkeley, in 1966 and 1968, respectively. His studies focused on the dynamic analysis of structures and structural design. He began his professional career at Teledyne in 1968. He left Teledyne and joined Holmes and Narver in Anaheim, California, where he specialized in the design and analysis of line of sight vent line closures for the support of the underground nuclear program at the Nevada Test Site. In 1974, he joined to the Engineering Decision and Analysis Company (EDAC) in Southern California. In 1983, he joined Structural Mechanics Associates (SMA) where his work focused on dynamic analysis of structures for the effects of earthquake shaking and blast loadings. He left (SMA) in 1991 to form a Southern California office of ABB/Impell, Inc. In 1995, he left Impell to join EQE, Inc. where he formed close friendships with a number of colleagues with like interests. He remained with EQE until joining Simpson, Gumpertz & Heger in 2008. During his career, Steve worked on soil–structure interaction analysis of large civil structures, dynamic analysis of structures and components, and evaluation of air-blast effects, and also developed codes and also standards such as ASCE 4 and ASCE 43.

Steve was an active member of the ASCE Committee on Dynamic Analysis of Nuclear Structures and its predecessor committee for nearly 40 years. He worked with Dr. Bob Kennedy to develop the probabilistic basis for much of the work adapted by the US Department of Energy in UCRL-15910, Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards, which later formed the foundations of ASCE 4-16 and ASCE 43-05. Steve was instrumental in promulgating these standards to the engineering community through DOE workshops and site-specific training.

Steve's influence reaches far beyond his contributions to civil engineering. He displayed a humble spirit, a tremendous work ethic, and a willingness to help others. Steve had a tremendously infectious, positive personality. He was very quick to smile or to make a joke. He was easy to talk with and extremely patient. As a senior member of the DANS committee and as a mentor to many, Steve never neglected to take the time to sit with younger engineers to work solutions to difficult problems. He never lost sight of the fact that civil engineering solutions ultimately serve to improve our quality of life.

Steve loved his family first, then sports. He was married to his wife, Gale, for 43 years and had three children. He never missed his children's many games, including football, baseball, soccer, cheerleading, or track meets. He was an extremely supportive husband and father and was always where he needed to be. He played basketball, volleyball, and was a downhill skier and a golfer. Steve was an avid fan of the California Golden Bears, the San Francisco 49ers, and the San Diego Chargers. He could recite statistics about baseball and football that amazed all, as that was one of his passions. He constantly cheered for the underdog, which may explain why he loved Cal football so much. He also loved music, and during his lifetime he attended hundreds of musicals and concerts. But his professional life was also extremely important to him and during his last few years of life under treatment, when he could have stayed home, he continued to do his job, never missing a day on which he could work in 46 years.

ASCE and the members of its ASCE DANS committee dedicate this 2019 edition of ASCE 43 to our friend and colleague, Stephen A. Short. Steve's contributions to ASCE 4 and 43 have been, are, and will be, sorely missed.

David K. Nakaki, Ph.D., P.E.
August 3, 1957 – December 9, 2019

ASCE 43-19 is dedicated to Dr. David Kiyoshi Nakaki, an expert in seismic/structural engineering for nuclear facilities, a devoted father, and a friend to many.

Dave was born and raised in West Los Angeles. He received all of his college degrees at nearby University of California at Los Angeles; Bachelor's of Science in civil engineering in 1980, Master's of Science in engineering in 1983, and Doctor of Philosophy in engineering in 1987. His doctoral thesis was titled "Uplifting Response of Structures Subjected to Earthquake Motions."

Upon his university graduation, Dave began his professional career in 1987. His career growth was represented by steady rise consistent with his talents through employment at NTS Engineering (1987 – 1988), Impell Corporation (1988 – 1991), EQE International / ABS Consulting (1991 – 2003), ARES Corporation (2003 – 2008), and Simpson Gumpertz & Heger Inc. (SGH) (2008 – 2019). Dave was a key member of the core group that founded the Orange County, California, office of SGH. He was licensed civil engineer in the states of California and Alaska. Dave's professional career was dedicated to ensuring public safety through the seismic evaluation of commercial nuclear power plants and US Department of Energy (DOE) facilities for design basis and beyond design basis earthquake events. He was an expert in all technical elements of such evaluations, including soil-structure interaction modeling and analysis, seismic response analysis, by deterministic and probabilistic methods, seismic capacity evaluation of structures, and experience-based seismic walkdown assessments of essential equipment. Dave was a longtime member of the ASCE Dynamic Analysis of Nuclear Structures Committee. He was the principal contributor to the provisions for probabilistic site response analysis, which were first included in ASCE/SEI 4-16.

Dave was responsible for beyond design basis evaluations of nuclear power plants by seismic probabilistic risk assessment (SPRA) and seismic margin assessment (SMA). His greatest achievement in this arena was completion of the Diablo Canyon Power Plant SPRA, a challenging project because of the high site seismicity. Dave also led SPRAs and SMAs in several other countries, including Canada, France, Germany, and Switzerland. He was responsible for seismic evaluations of DOE nuclear facilities implementing ASCE 4 and ASCE 43 at the Idaho National Laboratory, Los Alamos National Laboratory, Nevada Nuclear Security Site, Oak Ridge National Laboratory, and Pantex Plant.

Over the last several years of his career, Dave was essentially the Renaissance man of his engineering group. Besides providing project management leadership and being the "go-to" person for guidance on technical subjects, he was responsible for supervising younger engineers, recruiting new engineering talent, computer hardware and software management, and quality assurance. Dave seldom declined to provide assistance to others when asked. In those rare occasions when he did, it was only because somebody else convinced him he already had too much to do. Dave was particularly an excellent mentor of young engineers. He was a patient teacher always willing to offer advice and answer questions when asked. He made great contributions to development of the future leadership in our industry.

In the workplace, Dave was a treasured friend and colleague to all. He served as a great role model for the next generation of engineers through his strong work ethic. While he could present a private and reserved image, there were occasions when he would break out his incredible wit to the enjoyment of those around him. Conversations with Dave would also display his depth of knowledge of the world around him that went well beyond engineering. His presence is missed every day.

Dave was a dedicated family man. A devoted father to three children, Karen, Mitchell, and Claire, he spent many years coaching youth basketball or timing, stopwatch in hand at swim meets. More recently, he also stepped up and spent time each week with his mother. Dave was a proud Japanese American and could make the mochi to prove it. As he did with everything in his life, Dave took the time to perfect his Thanksgiving turkey and Christmas roast recipes and could find the best restaurants – sometimes hole-in-the-wall burgers, other times old school Chinese food or the freshest sushi. Perhaps most indicative of Dave's personality was his loyalty to the Grateful Dead. Beginning in his college years, Dave attended numerous live shows and wound up with hundreds of live recordings on vinyl, cassette tapes, and CDs.

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