Institute Lecture

Health Assessment of Civil Infrastructures

Professor Achintya Haldar

Professor and da Vinci Fellow,
University of Arizona, Tucson, AZ, U.S.A.

7th April 2016, Time: 6 PM, Venue: L-15

Abstract

Structural health assessment (SHA) and management have attracted interdisciplinary research interests all over the world. Infrastructures are deteriorating, some of them are over their design life, or they are being exposed to natural extreme events like strong earthquakes or high winds, or man-made like blasts or explosions. Due to severe shortage of resources to replace them, it is now necessary to extend their design life without exposing public to unnecessary risk. One approach has attracted a considerable amount of attention is inspecting the infrastructures as thoroughly as practicable in a timely manner to identify the defect spots quantify their severity and then take appropriate remedial actions so that they can be used for which they were initially designed. Researchers from many different disciplines are now concentrating on developing new mathematical techniques, inspection methods, necessary instruments or sensors, sources of energy require to operate the sensors in field conditions, etc. In spite of many significant developments in the related areas, their applications to assess health of real structures have been limited. The urgency in implementing some of these concepts cannot be over stated.

The presenter and his team members have been working in the related areas since early nineties. They conducted extensive theoretical, analytical, and experimental investigations and identified several challenges in implementing some of the advanced concepts in assessing health of real civil infrastructures. The team proposed several advanced implementation strategies. They crossed the disciplinary boundaries and are referred more by electrical than civil engineers. He recently edited a book on the topic.

The research team developed several novel structural health assessment procedures for linear and nonlinear structural systems using the system identification-based concept. Infrastructures are represented by finite elements and the systems are excited by dynamic loadings or due to ambient excitation. The health is assessed by tracking the stiffness properties of all the elements by comparing the identified values with the previous values from past inspections, if available, or using information from the design and drawings or studying the deviation from other elements expected to have similar properties. In this approach, the number, location, and severity of defects can be assessed satisfying the basic intent of SHA. The information is extracted from the hidden signatures embedded in few noise-contaminated acceleration time histories measured at small parts of the structure, only for very short durations, sometimes for a fraction of a second to avoid contamination caused by other sources of excitation beyond the control of the inspector, and completely ignoring excitation information. In the process, the research team proposed and significantly advanced different Kalman filter-based algorithms. These algorithms can detect small cracks, loss of area of a small part of an element to major defects, not detected during visual inspections, without stopping the normal operation of infrastructures. The presentation will be of interest to different engineering disciplines.

The presenter received numerous awards and around 25international invitations from all over the world to present some of these ideas. He published over 80 technical articles on the related topics and over 450 including several books on engineering analysis and design in the presence of uncertainty. His most research is supported by the U.S. National Science Foundation (CMMI-1403844). He just received an invitation to give a keynote speech on the related areas by the ASCE's Engineering Mechanics Division and the Probabilistic Mechanics Committee in May 2016.

About the speaker

Prof. Achintya Haldar received B.S. degree in Civil Engineering in 1968. He started his research career as a graduate student at the University of Illinois (M.S., 1973 and Ph.D., 1976). After graduate education, he spent two years working for the Nuclear Power Division of Bechtel Power Corporation in Los Angeles. Then he returned to an academic career, first at Illinois Institute of Technology, then at Georgia Institute of Technology, and now at the University of Arizona. He also taught courses at Hong Kong University of Science & Technology and at the Technical University of Ostrava in the Czech Republic. He visited the University of Tokyo and Indian Inst. of Science, Bangalore, at their invitations. Prof. Haldar has more than 3 1/2 years of practical experience in India.

Prof. Haldar conducts research exclusively on risk and reliability applied to many branches of engineering. He developed the stochastic finite element concept, several novel approaches for structural health assessment, and now working on developing a new engineering design paradigm supported by the U.S. NSF. So far, Prof. Haldar has published over 450 technical articles, including 10 books, 24 book chapters, and made numerous keynote and invited presentations worldwide. Prof. Haldar has advised a large number of graduate students. Some of them are now professor at major universities in the U.S., Canada, Jordon, Korea, Mexico, Taiwan, West Bank, etc. Some other students are now providing leadership in industries.

Prof. Haldar received numerous awards for research and teaching. He was elected a Distinguished Member of ASCE and a Fellow of SEI. He also received Life Time Achievement Award from the Society for Reliability, Presidential Young Investigator Award from President Reagan, ASCE's Huber Civil Engineering Research prize, Honorable Diploma from the Czech Society for Mechanics, inaugural da Vinci fellowship, Distinguished Alumnus Award, etc. Prof. Haldar was selected one of 23 Scientists and Technologists of Indian Origin abroad (STIOs) (may be the only engineer) by the DST, Government of India, for collaborative projects with Indian scientists and technologists.

Prof. Haldar received numerous recognitions for his exceptional teaching including Arizona Engineering Education Fellow, Accolades Outstanding Faculty Award, Outstanding Faculty Member Award, Professor of the Year Award, Student Interface Award, Burlington North Foundation Faculty Achievement Award, etc. At Georgia Institute of Technology, he received the Outstanding Teacher Award being the best professor.

Prof. Haldar is a registered professional engineer in California and now inactive status in Arizona, Georgia, and Illinois. He was the founding Editor-in-Chief of a journal "Engineering under Uncertainty; Hazards, Assessment and Mitigation."

Tea at 5.45 PM All interested are welcome.

Amalendu Chandra
Dean of Research and Development, IIT Kanpur