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Automatic Control and Systems Engineering

The Department of Automatic Control & Systems Engineering
is pleased to announce the following seminar:

Critical earthquake response of elastic-plastic structures under near-fault or long-duration ground motions (Closed-form approach via impulse input)

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Wednesday, 22 June 2016 at 14:00
LT02, Sir Henry Stephenson Building

Abstract

This talk is on the critical response of elastic-plastic structures under near-fault (Kobe earthquake 1995) or long-duration (Tohoku earthquake 2011) ground motions. In the early stage of dynamic nonlinear response analysis of structures around 1960s, a simple hysteretic structural model and a simple sinusoidal earthquake ground motion input were dealt with together with random inputs. The steady-state response was tackled by an equivalent linearization method developed by Caughey, Iwan and others. In fact, the resonance plays a key role in the earthquake-resistant design and it has a strong effect even in case of near-fault ground motions. In order to draw the steady-state response curve and investigate the resonant property, two kinds of repetition have to be introduced. One is a cycle, for one forced input frequency, of the initial guess of the steady-state response amplitude, the construction of the equivalent linear model, the analysis of the steady-state response amplitude using the equivalent linear model and the update of the equivalent linear model based on the computed steady-state response amplitude. The other is the sweeping over a range of forced input frequencies. This process is quite tedious.

To overcome this difficulty, a new approach was proposed.. Kojima and Takewaki demonstrated that the elastic-plastic response as continuation of free-vibrations under impulse input can be derived in a closed form by a sophisticated energy approach without solving directly the equations of motion. While, as pointed out above, the approach based on the equivalent linearization method requires the repetition of application of the linearized equations, the method by Kojima and Takewaki does not need any repetition. The double impulse, triple impulse and multiple impulses enable us to describe directly the critical timing of impulses (resonant frequency) which is not easy for the sinusoidal and other inputs without a repetitive procedure. It is important to note that, while most of the previous methods employ the equivalent linearization of the structural model with the input unchanged, the proposed method transforms the input into a series of impulses with the structural model unchanged. This characteristic guarantees high accuracy and reliability even in the large plastic deformation range. The proposed approach is an epoch-making accomplishment to open the door for simpler and deeper understanding of structural reliability of built environments in the elastic-plastic range.

The applications of the proposed method to soil-structure interaction problems, MDOF problems, elastic-plastic dynamic stability problems, rocking response problems of rigid blocks are also presented.

Biography

Izuru Takewaki received his B.Eng. and M.Eng. degrees in Architectural Engineering, in 1980 and 1982 respectively, and his Ph.D. with a focus on Earthquake Structural Control and Optimization Theory in 1991, from Kyoto University, Japan. He was promoted to Assistant Professor in 1982, Associate Professor in 1996 and Professor in 2003 in Kyoto University. He was a visiting scholar at the University of California, Berkeley (1989-1990) and a visiting professor at the University of California, San Diego (2005). He is an editorial board member in several international journals (Structural Control and Health Monitoring, Structural Design of Tall and Special Buildings, Soil Dynamics and Earthquake Engineering, etc) and serves as a Field Chief Editor of Frontiers in Built Environment (Switzerland) since 2015. His main research interests include the earthquake structural control, base-isolation, structural optimization and worst-case analysis using critical excitation methods (http://loop.frontiersin.org/people/166204/overview).

Light refreshments will be served in the
foyer of the Sir Henry Stephenson Building following the seminar