# Critical Excitation Methods for Important Structures New Paradigm in Earthquake Engineering ***

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There are a variety of buildings in a city. Each building has its own natural period and its origina structural properties although there exist a lot of uncertainties (Tsompanakis et al. 2008). When earthquake occurs, a variety of ground motions are induced in the city. The combination of the natural period with the predominant period of the induced ground motion may lead to disastrous phenomena in the city. Many past earthquake observations demonstrated such phenomena. O earthquake occurs, some building codes are upgraded. However, it is true that this repetition ne resolves all the issues and new damage problems occur even recently. In order to overcome th problem, a new paradigm has to be posed. The concept of 'critical excitation' and the structural based upon this concept could become one of such new paradigms (Takewaki 2006, 2008).

It is believed that earthquake has a bound on its magnitude. In other words, the earthquake ene radiated from the fault has a bound. The problem is to find the most unfavorable ground motion building or a group of buildings. A ground motion displacement spectrum or acceleration spectr been proposed at the rock surface depending on the seismic moment, distance from the fault, e spectrum may have uncertainties. One possibility or approach is to specify the acceleration or v power and allow the variability of the spectrum (Takewaki 2006, 2008).

The problem of ground motion variability is very important and tough. Code-specified design gr motions are usually constructed by taking into account the knowledge from the past observatio probabilistic insights. However, uncertainties in the occurrence of earthquakes (or ground motic fault rupture mechanisms, the wave propagation mechanisms, the ground properties, etc. caus difficulty in defining reasonable design ground motions especially for important buildings in whic damage or collapse has to be avoided absolutely (Singh 1984, Anderson and Bertero 1987, Ge 1997, Takewaki 2002, 2006, 2008, Stein 2003).

A long-period ground motion has been observed in Japan recently. This type of ground motion cause a large seismic demand to such structures as high-rise buildings, base-isolated buildings al. 2006), oil tanks, etc. This large seismic demand results from the resonance between the lon ground motion and the long natural period of these constructed facilities.

A significance of critical excitation is supported by its broad perspective. There are two classes buildings in a city. One is the important buildings which play an important role during disastrous earthquakes. The other one is ordinary buildings. The former one should not have damage duri earthquake and the latter one may be damaged partially especially for critical excitation larger t specified design earthquakes. The concept of critical excitation may enable structural designers ordinary buildings more seismic-resistant.

The most critical issue in the seismic resistant design is the resonance. The promising approac shift the natural period of the building through seismic control and to add damping in the buildin However it is also true that the seismic control is under development and more sufficient time is necessary to respond to uncertain ground motions. The book by Takewaki (2006) will help the development of new seismic-resistant design methods of buildings for such unpredicted or unpr ground motions.

It is stated in the book by Takewaki (2006) that the research by Dr.Takewaki was greatly motiva papers by Drenick (1970) and Shinozuka (1970). Dr.Takewaki communicated with Prof.Drenick and was informed that the work by Prof.Drenick was motivated by his communication with Japa researchers in late 1960's. After 40 years, a Japanese researcher has made remarkable advan this field.

## Further reading


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## Selected links

- Critical Excitation Book (Elsevier)
- Dynamic Structural Design (WIT Press)
- Engineering Structures (Elsevier Journal)

- Council on Tall Buildings and Urban Habitat
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