Modelling and Simulation of Seismic Isolation Systems

In this course, numerical modeling and simulation of passive seismic isolation systems and the earthquake behavior of structures equipped with such systems will be taught. First, the definition, basic terminology and the implementation of seismic isolation will be given. Then, details of 3D-BASIS program, which is a world-famous software that is capable of carrying out nonlinear dynamic analyses of base-isolated buildings, will be offered. As a practical application example, an actual modeling and seismic analysis of a benchmark base-isolated building both in 3D-BASIS and SAP2000 will also be conducted. Additionally, Uniform Building Code rules regarding seismic isolation will be summarized. Finally, the challenge of near-fault earthquakes faced by passive seismic isolaton systems will be examplified by actual time history analyses under historical near-fault and far-fault earthquakes.

Near-fault Earthquake Challenge for Passive Isolation Systems and the Semi-active Damping Solution

Seismic isolation offers the advantage of minimizing both the acceleration and displacement response of structures concurrently, which can not easily be obtained via conventional earthquake resistant design techniques. Thus, research on seismic isolation and its practical applications are becoming more and more popular each day around the world. On the other hand, it also faces challenges in case of near-fault earthquakes as these types of ground motions typically include high-amplitude long-period velocity pulses whose periods may coincide with the long isolation periods of seismically isolated structures. This phenomenon may cause very large base displacements to occur.

While use of high passive damping may be unavoidable to reduce large base displacements in case of near-fault earthquakes, it may cause high floor accelerations in case of far-fault earthquakes. A solution to this problem may be the use of semi-active damping which has the potential for reducing base displacements in case of near-fault earthquakes without increasing floor accelerations in case of far-fault earthquakes. In this seminar, the comparison of the seismic behavior of structures equipped with passive and semi-active seismic isolation systems will be discussed. The challenge of near-fault earthquakes faced by passive seismic isolaton systems will be examplified, followed by an introduction of semi-active isolation and proof of its potential in solving the aforementioned near-fault problem.