Team Develops Seismic Upgrade for Istanbul's Ataturk Airport Terminal

MCEER researcher Michael Constantinou was part of a team charged with the seismic upgrade of Istanbul's Ataturk International Airport. The upgrade of the structure, which was under construction at the time of the August 17, 1999 Marmara earthquake and scheduled to open in January 2000, was recommended by TEPE-AKFEN-VIE (TAV), the local build-operate-transfer consortium of the 190,000 square meter terminal and parking garage; and its advisor on construction management, New York-based Turner International. The upgrade had to be accomplished prior to the opening of the airport, and although the earthquake did not damage the structure, TAV wanted to strengthen it beyond the local code's requirement for life safety.

■ *Friction pendulum devices were installed to seismically isolate the roof of the airport terminal.*

The design and implementation of the upgrade, led by LZA Technology, a division of Thornton-Tomasetti Group, New York City, took less than four months. Other team members were Michael Constantinou, professor and chair of UB's Department of Civil, Structural and Environmental Engineering and an MCEER researcher, Andrew S. Whittaker, Associate Director of PEER, University of California at Berkeley, and Tuncel Engineering and Fondsiyuon Muhendislik Insaatvetic Ltd., both of Istanbul.

The modernization scheme consisted of three steps: 1.) increasing the strength of the second- and third-story columns by steel jacketing the columns, 2.) seismically isolating the roof to reduce seismic demand on third-story columns, and 3.) installing lock-up devices (shock absorbers) at roof expansion joints.

Professor Constantinou and his colleagues were involved in the development of the upgrade conceptual design, evaluating alternate solutions, performing nonlinear static and dynamic analysis of the structure, and assessing the displacement demand in the isolation bearings. The roof isolation scheme involved slicing the columns horizontally at the top and installing friction pendulum bearings, manufactured by Earthquake Protection Systems of Richmond, California. These devices, which were tested extensively at MCEER/UB, are designed to allow structures or structural components to swing gently from side to side, like a pendulum. According to Professor Constantinou, the segments of this 250-meter long roof were tied together as they sit on top of the isolation devices. This gives the roof the ability to "swing" as much as 300 mm with respect to the columns during an earthquake, thus protecting the columns.

However, the roof's direct exposure to the sun necessitated the use of expansion joints that could accommodate thermal movement. Lock-up devices, which are like shock absorbers, manufactured by Taylor Devices, were installed. They allow the roof sections to respond individually to thermal stresses under normal circumstances, yet during a seismic event, the devices engage in position, forcing the entire roof to behave as one element. This hardware was also tested extensively at MCEER/UB.

For overall project information, contact Emmanuel Velivasakis, LZA Technology, (212) 741-1300, *http://www.lzagroup.com*. For more information on the hardware, contact Anoop Mokha, Earthquake Protection Systems, (510) 232-5993, *http://home.att.net/~eps-fp/* or Douglas Taylor, Taylor Devices, Inc., (716) 694-0800, *http://www.taylordevices.com*. ❖