Announcing the Final Examination of Hasan Sazak for the degree of Master of Science

Time & Location: June 30, 2010 at 10:30 AM in Engineering 2 211 P
Title: Structural Health Monitoring of Human Induced Vibrations to a Stadium for Evaluating Human Comfort and Structural Performance

Light and rapid constructions as well as considerations such as improved line of sight and increased capacity for modern stadium structures make them vulnerable for vibration serviceability problems. These problems are also observed at convention centers, large shopping malls, concert halls and ballrooms. Especially when the individuals in a crowd are involved in some sort of coordinated motion, this type of loading creates the most potential for high levels of vibration. In order to understand the causes of vibration, vibration levels, service and safety levels, Structural Health Monitoring (SHM) can be implemented to track and evaluate performance of a structure during events such as games at football stadia. SHM becomes a critical need especially when decisions such as repair and retrofit are to be made for the structure. The main objectives of this study are a) to determine the impact of vibration to human comfort levels; b) to identify dynamic loading for the coordinated motion; c) to determine the structural performance by means of a detailed model validated using experimental data. In order to achieve these objectives, a football stadium was monitored for three years to establish the vibration levels during different games and different events in each game such as goals, interceptions, playing a particular song. It is seen that certain events and long periods of playing particular songs induced vibration levels that are at the threshold of human comfort based on the design codes. To simulate the crowd motion due to this song, a laboratory study was designed and conducted to experimentally determine the forcing functions due to jumping with the rhythm of the song. The spectral analysis of the stadium data and the song also revealed that the first mode frequency of the stadium and the dominant frequency of the music are very close, creating resonance conditions. Further investigative studies were conducted by developing a finite element (FE) model of the stadium, which was validated using the results of the modal analysis from the ambient vibration data. Subsequently, the FE model was employed to simulate forcing functions obtained from the laboratory studies to explore the vibration levels, dynamic response as well as the response of the structure when it is retrofitted by additional elements. In addition, different aspects of model development, with respect to the physical model of the stadium were outlined in terms of design considerations, instrumentation, finite element modeling, and simulating dynamic effect of spectators. Finally, the effectiveness of the retrofit by adding elements to the steel structure of the stadium was explored by simulating the crowd motion with the FE model.

Major: MS Structural and Geotechnical Engineering

Educational Career:
Bachelor's of Civil Engineering, BS, 2009, Middle East Technical University

Committee in Charge:
Dr. F. Necati Catbas, Chair, Environmental and Construction Engineering
Dr. Manoj Chopra, Environmental and Construction Engineering
Dr. Mustafa Gul, Environmental and Construction Engineering

Approved for distribution by Dr. F. Necati Catbas, Committee Chair, on March 22, 2010.

The public is welcome to attend.