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Synergies in Semiactive Control and Health Monitoring of Civil Structures

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Research developments in structural control and in health monitoring, as well as the synergies between the two, have the potential to significantly improve the safety of civil structures for various natural and man-made hazards. The development of structures that are safer and less costly to maintain is a fundamental goal of research in these areas. This presentation will start with some background on structural control topics and then focus on some current work on characterizing some effects of environmental conditions on structural parameter identification, and on developing a way to exploit the synergy between structural control and structural health monitoring.

Structural control techniques can be used to mitigate the vibrational effects of natural hazards such as earthquakes and strong winds. A background of structural control is presented here, focusing on the concepts behind it, current applications, and on how it depends on accurate characterization of structural parameters. Passive, active and semiactive strategies for mitigating structural motion are discussed and explained.

Structural health monitoring (SHM) seeks to use sensors to automate the process of damage detection in structures, whether damage due to natural hazards such as earthquakes or long-term degradation due to environment and aging. Significant research efforts have been focused on this topic in the last decade or two, with particular focus recently on new sensor technologies. However, the accuracy of most damage detection methods is strongly affected by consistency in the environmental conditions. The NEES Soil-Foundation-Structure-Interaction facility is used to study the effect of various environmental conditions, including temperature and moisture, on structural parameter identification. While temperature effects have been well identified by others, this study demonstrates significant dependence on the level of the water table in the soil.

A structural parameter identification method is developed based on a substructuring approach where a structural control system can be directly integrated to provide more accurate estimates of structural parameters. These estimates can, then, give more accurate characterization of structural damage as well as provide more accurate description of dynamic characteristics so that structural control can be more effective in mitigating damage from future natural hazards. This approach capitalizes on the synergies between structural control and structural health monitoring.

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