EERI-NSF Rapid and Research Needs Workshop

Breakout Session Title: Discipline Specific - Structural Engineering
Discussion Leaders and Recorders: Ayhan Irfanoglu and Robert Fleischman
Panel Members: Reginald DesRoches, Marc Eberhard, Barry Goodno, Anna Lang, Khalid Mosalam, Alexandros Taflanidis

Session Overview:
The large loss of life, loss of shelter and loss of infrastructure associated with structural collapse in the January 2010 Haiti earthquake underscores the crucial role of structures-related earthquake engineering research in seismic hazard mitigation in Haiti and other underdeveloped countries. The challenges in this research are associated more closely with developing engineering solutions that are tenable in underdeveloped countries, rather than purely advancing knowledge of seismic structural behavior.

Research should extend across the separate areas of seismic risk assessment, seismic-resistant design, and aseismic construction methods. This research impacts preparedness, performance, recovery and sustainability. The recurring theme during discussions in this session is that solutions that are feasible in developed countries are not fully transferable to countries with conditions similar to Haiti's. New and alternative design methods, construction materials, and emerging technologies must be considered.

Further, there are three classes of structures in Haiti that should be recognized: Non-Critical Engineered Structures; Non-Engineered Structures; and Critical Facilities. Each building group has different design and construction processes currently in Haiti, and different expected or required performance in an earthquake. In many cases, given the potential for large loss of life, research associated with cost-effective solutions for collapse prevention are warranted.

Finally, in order for the research to have broad impact, it is important to incorporate knowledge of the local conditions, cultures, and practices.

Specific Research Areas:

<u>Assessment of Existing Building Stock</u>
Due to differing topographical and soil conditions and modest construction changes, seismically vulnerable buildings survived the Haiti earthquake. Further, similar buildings exist in large numbers in other underdeveloped countries, and also in the United States. Thus, <u>the development of methods to identify, assess, and retrofit large inventories of vulnerable structures</u> is of high priority. In particular, these methods must be cost-effective and plausible

in the context of uncertain local expertise. This area also has potential applications for evaluating the large existing building stock in the eastern or central U.S., built without consideration of seismic loads.

Rebuilding/Future Construction

Research is required to develop new or improved methods for building reliable structures in Haiti and other underdeveloped countries. These structural systems must be economically and culturally appropriate, sustainable, and unlikely to collapse during earthquake or other natural hazards. Both (1) variations in design and construction of traditional structural systems, and (2) the development of new structural systems should be considered. The research should recognize the differences in the design and construction of engineered vs. non-engineered structures, and lead to the development of methods that address each situation.

Critical Facilities in Underdeveloped Countries

For countries like Haiti, where seismic hazard exists in the presence of a vulnerable existing building stock and limited services relative to the population, the need for robust critical facilities and infrastructure is paramount. Thus, it is important that research work toward methods of improving identification and hardening of essential facilities, infrastructure, and interdependent networks in a fragile society. Likewise, the impact of nonstructural performance, including loss of key electrical, mechanical and communication equipment must be assessed.

Key aspects of Research:

The following additional key aspects should be considered as part of or in parallel with research efforts:

- Improved Knowledge of Local Conditions: Potential research on the topics listed above is hampered by a lack of knowledge of the specific conditions in Haiti or similar countries. For example, the characterization of local materials and their effect on seismic performance; better characterization of seismic hazard and local site conditions; better knowledge of the local building practice; and better description of the available resources and cultural factors that would impact new building concepts.
- Improved practice: Practical in-situ material quality assessment and inspection.
- Use of new materials, alternative use of existing materials, introduction of new natural resources in a sustainable manner. For example, the use of rubble as aggregate.
- Emerging Technologies: The use of next generation sensors and systems for structural health monitoring.
- Education and Information Dissemination: Effective strategies for education and dissemination of information on proper design and construction techniques.