Findings and Conclusions

16th US-Japan-NZ Workshop

June 27-29, 2016

Sessions – Resilience is the Theme

- Session 1: Resiliency Based Engineering
- Session 2: Post EQ Repair and Residual Capacity
- Session 3: Innovative Design
- Session 4: Risk Identification and Reduction
- Session 5: Earthquake Response and Recovery
- Session 6: Technologies in Developing Countries
- Session 7: Nonstructural

Session 1: Resiliency Based Engineering

- Compliance (meeting code requirements) is no guarantee of future performance, but is a start. Not a good start if it is minimum requirements. It is a better start if performance objectives are aligned with societal needs.
- Acceptance criteria based on limited data increases uncertainty. We need to tie performance to experience.
- Japanese code is minimum design, and buildings may not be usable following an earthquake. Only 10% of building cost is seismic design. We can afford better design.
- A clear translation of resilience is needed in Japanese. Perhaps: strong after beating.
- We need to consider siting and land-use planning impacts on performance

Session 1: Resiliency Based Engineering

- Resilience is in its infancy. We cannot communicate something that we do not understand well.
- We need to better understand the link between component-based design and system level performance
- Codes provide us a minimum standard. We need to evolve to promote best practices for serving society.
- Prescriptive codes are clumsy. We can design better codes if we better define the objective.
- There is a misconception about resilience. Codes define forces on a structure. Structural systems need to be thought of in terms of the societal need.

Session 1: Resiliency Based Engineering

- We do not yet have codes for infrastructure distribution systems. We need targets for acceptable levels of service interruption.
- Communication is important. We need multi-language, multi-cultural sharing of information.
- Overreliance on MCE turns off good judgement. We need to review the entire system to understand how it might fail to improve the performance.
- Performance can only be captured probabilistically. Experience is anecdotal. We need to be careful about reliance on only what we have seen in the past.
- Reliable load paths provide good performance.

Session 1: Resiliency Based Engineering

- Resilience is not just an engineering problem. We need to engage with society and create buy-in for what is needed for resilience and what that means to non-engineers.
- Damage and loss are not the same thing. Damage does not necessarily mean loss. We need to minimize loss (e.g., repair costs, downtime, injury, life loss).

Session 2: Post EQ Repair and Residual Capacity

- The decision to demolish is not only related to the level of damage.
- Many factors determine the cost of repair, which would lead to demolition.
- In Japan, demolition is paid by the government or prefecture.
- There is a challenge in dealing with the profitability of an undamaged building in post EQ environment
- Guidance for assessment of RC buildings in Japan (old method) was found to be potentially conservative in BRI tests. The new method averages over the building height. More research is needed.
- Testing protocol needs to be evaluated for assessing residual capacity

Session 2: Post EQ Repair and Residual Capacity

- More data are needed to understand the cost of repair at which repair is not selected.
- People do not like to live in a damaged building.
- Japanese guidelines do not consider the number of cycles directly, but it is implicit in the testing used for calibration.
- We need to evaluate the effectiveness of repair methods for damaged concrete buildings.
- We need to repair tested specimens to explore levels of damage that can be repaired.
- The participating organizations resolve to collaborate on the development of residual capacity guidelines

Session 3: Innovative Design

- Do our design procedures capture non linear torsional response? We need to look at stiffness and strength together and understand current procedures that exist.
- Current analytical procedures used for design do not capture the randomness of failure - does it change the collapse behavior or probability?
- Collaboration to understand the gap between finite analysis and a full scale test.
- Compare the designs (level of innovation) between the US/Japan/NZ to see if what lessons can be learned.
- Define the barriers to the innovation and how to ensure robust innovation.
- We need innovative design for construction types that represent the most common types of buildings (not just special or important structures).
- Innovative design could include innovative treatment of the supporting soil.
- Holistic design principles should be considered with innovative solutions.
- Get the information from the field to those who influence the fields of practice.

Session 4: Risk Identification and Reduction

- We need a re-definition of damping, and need to take a new look at damping and what it means.
- We must not forget the basic life-safety intent of the codes.
- We must address the risks in our existing building stock.
- NZ is adopting a mandate to allow investigation of failures (not from a liability point of view)
- Seismic risk is not the only risk (e.g., tsunami, fire, multi-hazard)
- We must remember that our work is focused on serving and protecting people.
- We need to consider how our work impacts people (and who cares).

Session 5: Earthquake Response and Recovery

- We should study comparable cities that have gone through massive earthquakes to compare response and recovery efforts and lessons that can be learned.
- We need to document successes so that we know where codes are working.
- Education and awareness only contributes about 7% to behavior change (social science perspective).
- Policy, regulations, economics (rewards/punishments), contribute 93%.
- Conservatism in design and construction should be considered in a commercial context. We need to communicate the case for conservatism.
- We should study peak acceleration, damping, and spectral response to better correlate with observed damage.
- We need to improve our analytical predictors for damage.
- We need to establish professional norms for design and construction that say how people should behave (rather than trying to force compliance).

Session 6: Technologies in Developing Countries

- We need to adapt our seismic technologies and share appropriate technologies (and processes) with developing countries.
- We should develop an international standard that can be applied to countries internationally.
- We commend JICA for their efforts.

Session 7: Nonstructural

- The cost-benefit ratio of nonstructural bracing needs to be considered (including consideration of downtime and design fees).
- Need clear definition of roles/responsibilities.
- One solution to the vulnerability of ceilings is to omit ceilings.
- Structural response can impact nonstructural damage exposure. Holistic structural and nonstructural design is needed (especially for new construction).
- We might need to pay more attention to existing building stock; the cost-benefit ratio might be different.
- We need to integrate suppliers into seismic design problem.

Session 7: Nonstructural

- Heavy suspended ceilings need special consideration. Lightweight lay-in tiles may not.
- Increased focus on design and coordination is leading to a new design specialty.
- For success in nonstructural implementation, we need to take advantage of the broader partnerships in the building industry: design, regulation, enforcement, and manufacture.