

Resilience of Infrastructure

Tuna Onur¹ and Rengin Gok²

¹ Onur Seemann Consulting

² Lawrence Livermore National Laboratory

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.

This is LLNL-PRES-691154

Resilience of Infrastructure

Reliability & Resistance

Redundancy & Maintenance

Response & Recovery



Capacity Building

Equipment & Instrumentation
Education & Training
Measurements & Data



Science & Engineering

Disaster Risk Research
Probabilistic Hazard
Engineering Design & Analyses

Codes & Regulations

Construction Codes
Disaster Related Design Loads
Code Compliance



Example Project

- US Department of Energy – International Seismic Cooperation
 - Lawrence Livermore National Laboratory
- Long-Term Support for National Governments (Middle East, Central Asia, Caucasus)
- All Elements of Code Development Support
 - Capacity Building: Instrumentation, Training, Data
 - Science & Engineering: Research Collaboration
 - Code Development: Generation of Supporting Information (Hazard Maps) for Seismic Provisions

Code Development – Challenges

Developing Countries

- ❖ Coordination
 - Government
 - Private Sector
- ❖ Modernization
 - Science and research
 - Code updates
- ❖ Enforcement
 - Responsibility
 - Consequences

Developed Countries

- ❖ Overarching Policy
 - Consistency among codes
- ❖ Expectations
 - Code developers
 - Public
- ❖ Performance-based codes
 - Explicit criteria

Coordination of Code Development

Codes are typically developed at the national level but enforced at the local level.

Broad-based
Committee



Performance
Targets



Review &
Update



Expectations from Codes

Migration towards performance-based codes allow clear and explicit performance goals.

- Expectations of code developers vs. public
- Performance of buildings vs. infrastructure
- Who is coordinating the code development?
 - Building codes: Typically government
 - Infrastructure codes: Mixed

Existing Infrastructure

Codes are typically developed for new structures and guidelines for existing structures.

- Codes are mandatory and enforceable (law), while upgrading of existing structures are typically NOT mandatory
- Drivers for decision making:
 - Cost
 - Protection of lives, public interest & investment (owner-built vs. developer-built)