WORKING GROUP ACTION PLANS, FALL 2014

An outcome of the Strategic Thinking Retreat in July 2014 was the creation of working groups, assigned to develop each topic idea of interest. A detailed list of the proposed action plan for each activity is summarized below. The activities identified include the following:

- **Rapid Visual Screenings and Inventory of Schools** (Working Group 4), page A2
- **URM FREE BY 2033** (Working Group 2), page A6
- **Seismic Vulnerability of New Schools** (Working Group 1A), page A11
- **Seismic Vulnerability of Existing Schools** (Working Group 1B), page A15
- **Education & Outreach at Schools** (Working Group 5), page A19
- **School “How To” Documents** (Working Group 3), page A22
- **Post-Earthquake Evaluation of School Performance** (Bonus), page A24
NAME OF WORKING GROUP

Rapid Visual Screenings and Inventory of Schools

Task Group #4

GOAL STATEMENT

Utilize the expertise and influence of EERI to increase the number and quality of Rapid Visual Screenings (RVS) and Inventory of schools across the nation by conducting local inventory/RVS efforts utilizing EERI members and chapters, developing an informational website and database that shares best practices on conducting RVS, advocating the importance of screening schools to decision makers, and identifying funding sources to support these efforts.

The success of the project would be measured by the number of RVSs completed annually being higher than the preceding year (with a goal of 20-50 screenings per year) and by the annual number of engineers and university students participating in RVS or inventory efforts (with an annual goal of 200).

(SMART criteria: Specific, Measurable, Achievable, Relevant, Time Bound)

TEAM MEMBERS

Laura Kelly (Chair), Gary Lee Patterson, Phil Gould, Mel Musson

BACKGROUND

It is well-known by EERI members that, in seismically active regions throughout the United States, thousands of students/staff unknowingly convene in structurally vulnerable school and university buildings. Further complicating the issue is that there is no unifying organization for identifying and mitigating these structures due to the basic fact that these buildings are owned by countless numbers of local entities (public, parochial, charter, state, and private). In contrast, school buildings in Canada are owned by the individual provinces, so identifying & mitigating hundreds of at-risk schools in the entire British Columbia region has happened quickly and effectively due to management by a single government entity. In the United States, only an occasional state, such as Oregon, succeeds in adopting a state-wide policy to address the problem. To assist in overcoming these issues, EERI's School Safety Committee wants to increase the number and quality of Rapid Visual Screenings (RVS) and Inventory of schools across the nation.

FEMA's Rapid Visual Screening (RVS) has proven to be one of the simplest and more effective methods for quickly and easily identifying at-risk structures. RVS also creates a numerical “S” value that enables sorting at-risk structures from high to low risk, and further quantification of collapse probability and prioritization of mitigation based on life-safety risk. See following figures, as an illustration:
ACTION PLAN DETAILS

This initiative needs to engage EERI members and chapters around the nation so that they are motivated to advocate for and conduct RVS and inventories of schools at a regional level. For this project, schools will include K-12 schools, colleges, and universities, however it is acknowledged that their characteristics as well as mitigation approaches and mechanisms will be different and should be tracked separately. By empowering geographically diverse groups or EERI chapters and members, the approach can be customized for local regional culture, conditions, and characteristics. This will also include establishment of regional priorities and focus areas, including whether to focus on schools or universities. For example in mid-west regions, it may be appropriate to use this as an opportunity to screen for multiple hazards beyond earthquakes. In other regions it may be critical to forge partnerships with other Professional Engineering Associations (i.e. Structural Engineers Associations, American Society of Civil Engineers, Society of Women Engineers, and Natl. Society of Professional Engineers, etc.) to conduct RVS activities. It is expected that progress regionally will eventually yield a nation with safer schools.

Local EERI teams would advocate the need for RVS to local stakeholders, provide professional oversight to RVS efforts, coordinate RVS data collection activities (if conducted by volunteer EERI members), and offer participating engineers professional development hours if they are licensed professionals that complete RVS for school buildings or education credits if they are university students whose work is overseen by qualified individuals. The EERI SSSI RVS Working Group would insure that these local teams meet to share progress and best practices throughout the year, so that the efforts are aligned.

Because of the sensitive nature of the issues at hand, the EERI SSSI RVS Working Group and local teams will need to consider the confidentiality of the RVS results. At a minimum EERI would want to be able to track participation by state, entity, specific structure, and final RVS score via an internal tracking system or database. This tracking would help to prevent duplication of effort by various agencies in the same region. Success and measurement requires tracking to gauge effectiveness, but reporting should be sensitive to participants needs. This may need further review throughout the effort since there are pros and cons to transparency vs confidentiality.

An important element to this plan is the development of an informational website that shares national best practices on conducting RVS and contains a searchable database where decision makers and the public can
see documentation of RVS that have already been completed. It will be a place where recommended processes can be found for RVS, including (1) How to do RVS (process, training, documentation, etc.); (2) How to fund; (3) What people to engage; (4) Best practice process for RVS with U.S. examples; and (5) Resources, i.e. ATC existing trainings. As the project grows, this website resource is intended to be a single-point resource where any entity in the United States can seek assistance in identifying its at-risk school buildings.

It may be possible to accomplish this endeavor by seeking funding potentially on an annual basis from FEMA, who is already providing such funding for a pilot RVS study of schools involving the collaboration of EERI, the Alaska Seismic Hazards Safety Commission, the Matanuska-Susitna Borough School District, and an Anchorage-based structural engineering firm. The hope is that this model could potentially be expanded to other entities not only within, but beyond the state of Alaska, as well.

ACTION PLAN TIMELINE

Year ONE – 2015:

1. Develop and further define action plan goals, objectives, and timelines.
   a. Review and document RVS efforts that have been done to learn best practices, i.e. Oregon (statewide list), Utah (interactive map for screened buildings – created some interest, but also created pushback from school districts)
   b. Develop a list of ideas and action steps for local groups to take action including (1) How to do RVS (process, training, documentation, etc.); (2) How to fund; (3) What people to engage; and (4) Resources, i.e. ATC existing trainings

2. Directly communicate with EERI regional chapters and solicit their engagement

3. Identify EERI regional chapters project managers and leads in each region
   a. Solicit partners and synergy from other professional societies, i.e. SEAs

4. Identify funding source, confirming sustainability and amount for Year 2 RVS efforts:
   a. Advocate to Seismic Safety Commissions, WSPC, or other OES at states who can add RVS to list of annual requests they send to FEMA. Also consider aligning these requests with other groups, i.e. SEAs, etc. who can support those efforts.
   b. Encourage EERI to clearly advocate that this is an EERI priority that FEMA and others should fund.

5. Identify potential participants (states, FEMA representatives, seismic safety commissions, universities, state departments of education, school districts, etc.)

6. Establish server, database, software, and data management system including support personnel to create the RVS website and database

Year TWO – 2016:
1. Coordinate roll-out by participating EERI Chapters & member teams

2. Identify completion dates with final year-end tally and final end-of-year report

3. Review effectiveness – determine “go” or “no go” for following year and re-implement if success. Make necessary adjustments to either improve process, or a final determination to discontinue if not effective/viable/sustainable

4. Identify funding and confirming sustainability for following year.

5. Goal: 10-20 school screenings

Year THREE – 2017:

1. If viable, incorporate changes

2. Re-implement, followings same outline for Year 2

3. Goal: Increase goal to 20-40 screenings for year, with ultimate goal of increasing screenings by doubling growth in screenings each year for 5 years total, with an ultimate range of 80-160 screenings every year.

If EERI could ultimately screen 100-200 schools per year, it would be making a significant contribution to identifying structurally vulnerable schools on a national level... a notable accomplishment.
VISION:
Create a mechanism to achieve “URM FREE BY 2033”, meaning that no students will attend public school in unreinforced masonry buildings in high and moderate seismically active areas of the U.S.

ADVOCACY TEAM
Yumei Wang (lead), Heidi Tremayne (staff), Ken Goettel, Phil Gould, Micah Hilt, Ayse Hortacsu, Julie Mahoney, Mike Mahoney, Laura Samant, Barry Welliver, Edward Wolf, and Ivan Wong

BACKGROUND
“Schoolchildren have a right to learn in buildings that are safe from earthquakes” (NEHRP ACEHR, 2012). Efforts to support progress on school seismic assessment and mitigation in the highly decentralized U.S. public education sector is needed (Wolf and Wang, 2014). Nonductile school buildings, which are under-reinforced buildings prone to catastrophic collapse, are unfortunately common in many areas that are capable of generating damaging earthquakes. Unreinforced masonry (URM) and under-reinforced concrete were commonly used in school construction in many parts of the United States, especially during the early to mid twentieth century (Figure 1). These structural types have inherent serious vulnerabilities to ground shaking particularly in places where local building codes lagged behind current scientific understanding of the seismic environment. This effort will focus on URM school buildings, but can also be a resource to support mitigation of other vulnerable building types, such as nonductile concrete, lightly reinforced masonry and tilt-up concrete.

Public school buildings constructed prior to adequate seismic building codes share seismic deficiencies common to other buildings of the same structural types in the same setting, but several considerations set school buildings apart from their peers in terms of priority for seismic assessment and retrofit:

- Schools are the only high occupancy public buildings other than prisons and courthouses whose occupants are compelled by legal mandate to be inside them.
- Students are considered to be a vulnerable population due to their age and their developmental stage. Children are dependent on adults to provide safety, whereas adults are presumed capable of being consenting and accepting risks.
• School buildings in many communities tend to remain in use longer than comparable structures in private ownership, and tend to receive less frequent and less consistent capital renewal investment.
• Community members and public officials often hold a high (if unfounded) expectation that schools will provide community shelter or host public services in the wake of a natural disaster. (Wolf and Wang, 2014).
• School buildings often have large assembly rooms (e.g., gyms, auditoriums), which can increase their seismic vulnerability, making them more vulnerable than other buildings of similar construction types.
• The collapse of a school building is particularly devastating to communities because schools can hold an entire generation (i.e., all children of a certain age range in the community), a community’s future.

Early efforts to eliminate URM schools have been underway since the 1933 Long Beach, California earthquake (California Seismic Safety Commission, 2007; California State PTA, 1989). Except California, all states are suspected to have students attending URM schools (Oregon Legislative Assembly, 2012; Oregon PTA, 2011; Reitherman, 2009; Wolf and Wang, 2014). To protect students at risk in URM school buildings, the EERI Advocacy Team proposes to create a user-friendly mechanism to, where needed, identify and mitigate the risk posed by public school buildings that are unreinforced masonry buildings in high and moderate seismic zones in the U.S (Figure 2). The high and moderate seismic areas are those shown in red, orange and bright yellow. This new effort is referred to as “URM FREE BY 2033”.

Figure 2. 2014 National Seismic Hazard Map showing peak ground accelerations with a 2 percent chance of being exceeded in a 50-year time period.
Goal 1

Develop strategy for engaging with school stakeholders:

- Refine vision, motivation, and justification to support URM-FREE by 2033. This could include policy statements, motivational documents, etc. for partners to adopt.
  - Develop resources (documents, slides) to support advocacy
  - Clarify whether this effort supports a) abandonment or replacement all URMs with modern current code structures or b) “a” plus retrofit existing URMs, or c) a blend of both approaches. If retrofits are included, what level of seismic performance is recommended (collapse prevention and life safety criteria, probabilistic ground motions with specified return periods, etc)?
  - Clarify if there is any basic statement that should be made for low seismic regions that are not the focus of the initiative, i.e. minimum standards for new school buildings that will gradually replace URMs over time.
- Identify and define high priority regions
  - Based upon hazard criteria, vulnerability of building stock, and population density.
  - Survey where work has been done, and where it has not yet been completed.
  - Identify areas where more work is needed, AND where EERI volunteers are motivated to act.
- Enlist involvement of EERI members or chapters into local working groups
- Develop comprehensive list of possible partners and stakeholders at various levels that could be contacted by EERI members and working groups.
  - Establish links to important local partners who are unfamiliar with earthquake risk mitigation but could support a “bottom up” approach to school risk reduction:
    ▪ Associations of school district facility staff, Superintendants, etc.; PTAs; modernization committees; School Districts; National Education Association; etc.
  - Establish links with earthquake risk reduction advocates to support a “top down” approach to school risk reduction within their jurisdiction:
    ▪ State earthquake safety commissions, state agencies responsible for schools, etc.

Timeline: Spring 2015

Goal 2

Conduct outreach to partners that increases awareness and encourages them adopt earthquake safety policies to mitigate risk caused by URM schools and support “URM-FREE by 2033”.

Timeline: Summer 2015- Summer 2020
Goal 3

Use existing inventories that have already been completed (i.e. Oregon, Alaska, Utah, Washington, etc.) to create and populate an online database and interactive website of best practice examples. This resource would provide good examples for other school districts to consider when developing a mitigation program or policy. This resource should include the following for each best practice:

- Identify what (or who) motivated action
- Outline procedures/approaches used to mitigate or identify their risk
- Show how these states/school districts dealt with the ethical issues of inventories and databases of vulnerable school buildings.
- Include information on retrofit and replacement costs, as well as approaches used to fund these programs. These best practices will be important since retrofit and replacement costs are a critical issue for most school districts.
- Include information on any cost-benefit analyses used as a decision making tool.

Timeline: Summer 2015

Goal 4

Establish a framework for EERI members to conduct URM school inventories. This data can help us engage with stakeholders and motivate change by clearly defining and scoping the problem.

- Define geographic targets for these inventories, based upon hazard criteria, where inventories have already been completed, vulnerability of building stock, and population density.
- Identify a 5-year timeline for these inventories and set annual targets for number of school districts or buildings surveyed.
- Consider using or recommending a benefit-cost analysis to quantify the benefits of replacing/retrofitting URMs. Various existing approaches from best practice locations should be studied, i.e. FEMA BCA software, Oregon BCA tool, Washington BCA tools, etc.
- Consider mobile enabled tools for data collection.
- Discuss responsible (legal, ethical, etc.) presentation of this data for the public. (see also Goal 6)

Timeline: Summer 2015

Goal 5

Conduct and develop URM inventories using FEMA’s rapid visual screening (RVS) (FEMA 154, edition 3, 2014). Consider other screening criteria such as those used by WA K12 schools and the Oregon Seismic Rehabilitation Grant Program.

Timeline: Start Summer 2015 and continue to conduct surveys to achieve annual targets through 2020.

Goal 6

Develop a release strategy the results of the URM inventories to the public through a series of appropriate mechanisms. Mechanisms to be considered include:
• Develop a package of materials that can be presented to community leaders with the findings of the surveys. This should include a statement of the problem (general and specific findings of survey), next steps (i.e., a more detailed assessment of potential URM schools), possible solutions and their scope (retrofit vs. replacement, potential costs), and resources that can help.
• Link school districts that have addressed their URM schools with school districts just beginning to grapple with this.
• Compile a national report defining the size of the problem, with a national press release.
• EERI chapter press releases or press conferences. Before state/local press releases, it would be beneficial to provide information to local school districts, elected officials, etc. so they can try to come up with a plan before facing the press. This is more likely to make them feel like partners rather than adversaries.
• Explore incentives (any chance of grants to help school districts respond?), and sticks (probably press conferences are the strongest stick we have, or state level legislation) to motivate action in many communities. Partners may be needed to help with this.

Timeline: Early September 2020 (or earlier as appropriate in local areas with early progress)

REFERENCES


Oregon Legislative Assembly. 2012. Senate Bill 1566, Relating to Seismic Information About Schools, Sponsored by Senate President Peter Courtney. Online: http://www.leg.state.or.us/12reg/measures/sb1500.dir/sb1566.en.html


INTRODUCTION

Increased seismic design requirements in building codes are the first step in improving the expected performance of school buildings in earthquakes over time. The United States Geological Survey (USGS) annually records an average of nearly 1,500 earthquakes of magnitude 5 or greater worldwide. Damaging earthquakes may seem infrequent when compared to seasonal natural hazards, but this is not always the case. For example, the probability of high earthquake ground motions in the Midwest in the New Madrid Seismic Zone is a factor of ten higher than for EF2 or greater tornadoes at a given location. Earthquakes can be very high-consequence events. For schools, the consequences could be catastrophic for children in seismically vulnerable school buildings should an earthquake occur during school hours. Every child has the right to attend school in a safe building. The occurrence of a specific earthquake cannot be predicted in advance. Therefore policy must be proactive. The 2011 Virginia earthquake resulted in $30 million in damage to schools in an area that had not experienced a major earthquake since 1875.

There is a need for dialogue and dissemination of information regarding school building code provisions. Focused reflection and reconsideration of established code provisions pertinent to the following issues is needed given the unavoidable occurrence of significant earthquakes in areas and regions where such events are not generally anticipated.

1. Risk Category of School Buildings.

   Background: Schools are categorized as Risk Category (or Structural Occupancy) III in the International Building Code, unless used as post-disaster emergency shelters in which case they are classified as Risk Category IV (essential facilities) in the 2012 IBC. As a minimum, new schools should be safe and usable during repair after an earthquake. Schools to be used as shelters should be able to be occupied without restriction (e.g., receive an official "green tag" by inspectors) after the expected earthquake.

   Currently, for new school buildings in low seismic areas (even if used as shelters), hospitals, fire stations, police stations and all other essential facilities, there is no differentiation of the IBC seismic design requirements from those for ordinary buildings. In the Eastern US, general hazard mapping values in areas that use IBC-09 mapping, for soft soils (Site Class E) and stiff soils (Site Class D), the shaded areas in Fig. 1a and 1b would have design acceleration SDS greater than 0.33 g, which would place new structures for all structural occupancies in an SDC of C or D. These areas include New York City and Boston. However, for rock or very stiff soil conditions, the SDC is low (A, B or at the most C) for schools (even if used as shelters), hospitals, fires stations and police stations. With upcoming applications of IBC-12/ASCE7-10 mapping, the shaded areas will be significantly reduced. With small reduction in the mapping values in succeeding versions of USGS (say on the order of 5%) in the Eastern US, the SDC requirements are reduced by one category level, as shown on Table 1.
School districts need to be in the loop on the designation of their buildings as emergency shelters. This is sometimes done by local or state government without the explicit understanding of the designation by the school boards and administrative personnel. Note that this issue directly relates to issue 4 given the current structure of the code requirements.

Path forward / advocacy: The use (or non-use) of a new school as an emergency shelter should be specifically designated on the building permit application. The Authority having Jurisdiction should require a sign-off by the government emergency management agency responsible for emergency planning, response and recovery for the area in which the school is located. Categorizing all schools as Risk Category IV would reduce some of the complexity of this issue and would move the design to a higher detailing level in areas of low and moderate seismicity.

Figure 1. Regions with estimated $S_{DS} > 0.33$ g (SDCs C or D), assuming: (a) stiff soil D and (b) soft soil E (shaded in red). IBC-09 mapping (Nikolaou et al., 2012).

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<tr>
<th>SEISMIC DESIGN CATEGORY</th>
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<td>Structural Occupancy Category</td>
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Table 1. Typical shift (shaded in gray) in SDC when moving from IBC-09 to the reduced IBC-12 hazard mapping. Schools in very hard rock (Class A) and soils (Class D, E) will be designed without seismic detailing requirements for Class A rock or lower requirements by 1 level (Nikolaou, 2013).
2. **Building code design parameters in lower seismic areas.**

Background: The use of “Seismic Design Category A” is allowed by the International Building Code for design of buildings in areas of low seismic hazard. This provision is not appropriate for school buildings. There is no differentiation by Risk Category if Seismic Design Category A is allowed. The emphasis on soils type, the variability of the attenuation functions, and the impact of steeper gradients in the mapped values result in highly variable and changing seismic design requirements for areas such as the Front Range Urban Corridor of Colorado. As a result, the design of new school buildings may include little or no seismic resistance in areas where the earthquake hazard may not be well characterized. This cannot be an “acceptable risk,” especially considering that schools are often used as post-earthquake emergency shelters. It is interesting to note that the design acceleration limits that define SDC (Table 11.6-1 and -2 in IBC) have been derived mostly from data of the 1994 Northridge (California) earthquake, involving records where near fault motion effects were evident. Using these limits, SDC A is not applicable in the high seismic area of the US. However, in other areas it can result based on the requirements of $S_{DS} < 0.167g$ and $S_{D1} < 0.067 g$. Nonetheless, large concentrations of people and many schools are present in these areas as well. These areas need to also provide a level of safety for students that provide some minimum SDC seismic detailing requirements that are higher than the basically non-existing SDC A requirements.

Path forward / advocacy: The use of Seismic Design Category A should be prohibited for new schools. Areas of very low design acceleration values can remain exempt ($S_s < 0.15$ and $S_1 < 0.04$).

3. **The emphasis on soil (Site Class) factors in the building code and the variability of these factors in the real world.**

Background: Site Class is a major building code factor in determining the Seismic Design Category and the design ground motions. While it is important to include site effects, the actual response of buildings in earthquakes indicates that these factors may be un-conservative or inaccurate, especially where earthquakes are infrequent. This was observed in the Mineral Virginia earthquake of 2011. Regional Central-Eastern US soil conditions may generate significantly higher accelerations than those predicted by the western-US based generic code factors due to the high impedance contrast between bedrock and overburden soils and the lower level of ground motions that make the soil behave in a more linear manner. When the “true” site response is considered, the seismic design values SDS and SD1 can increase the SDC seismic detailing requirements.

Path forward / advocacy: Further research on soil factors and attenuation is needed. Adjustments need to be made to address regional soil conditions in the Eastern US. This research is on-going but there will always be uncertainty in the absence of actual earthquake ground motion records. This uncertainty is part of the justification for consideration of the other issues listed here.

4. **A minimum Seismic Design Category for all schools.**

Background: The current minimum is “Seismic Design Category A” which provides for only a 1% g lateral force and does not use the ground motion spectral accelerations available from the USGS hazard maps. SDC A/B breakpoints based on only WUS data, questionable code-based site coefficients especially in the CEUS / EUS, plus this lack of differentiation by Risk Category open the door for excessive seismic vulnerability for these new buildings. In low or moderate seismic hazard regions, the 2012 International Building Code allows the use of Seismic Design Category A. Some governments have amended the code to prohibit the use of SDC A. Since uncertainties in the seismic hazard maps are often high in the low or moderate seismic hazard regions, use of SDC A is inappropriate for schools. Risk is substantially
increased when seismic design is not performed. The Western States Seismic Policy Council recommends a minimum of Risk Category IV and Seismic Design Category C as part of their policy recommendation for the design of new schools.

Path forward /advocacy: Develop a matrix of Seismic Design Category options for schools as a function of use as a shelter, the seismic risk and other factors. This qualitative analysis need not start from the current building code provisions. Ultimately the outcomes can be compared to the current code (quantitative) provisions and further evaluated against these current code provisions. Certain aspects of structural and non-structural detailing may be chosen as most critical to ensure acceptable performance during the design earthquake. Some of these can be “common sense” solutions for furniture and equipment that can be easily enforced without special engineering calculations (see also next item). Note that this issue directly relates to issues 1 and 2 given the current structure of the code requirements.

5. More school specific design and details and possibly increasing the hierarchy of non-structural design requirements in lower seismic zones.

Background: School buildings have certain common characteristics. Could there be a focus on certain elements of the structure and non-structural attachments, specifically emphasizing school construction, to improve the safety? To ensure non-structural components are anchored and designed appropriately for schools, attention must be given to the outcomes that are achieved through the use of the various Risk Categories and Seismic Design Categories. Consideration should be given to maintaining more robust seismic design criteria for components by ignoring or changing component design exemptions that may be available within the code. Certain components, including fire protection systems for school buildings, should always be required to function after an earthquake. For Risk Category IV buildings, such as schools that are required for shelters, all seismic component anchorage and performance design must provide for continued operation of the facility (see also item 4).

The following is worth noting since cost concerns must always be considered. Per the recent “Cost Analyses and Benefit Studies for Earthquake-Resistant Construction in Memphis, Tennessee” (NIST GCR 14-917-26), even in a high seismic zone such as Memphis, the “implementation of seismic design requirements for school buildings will result in total construction cost increases of 1.0% for current local seismic code (1999 SBC) requirements, and 1.4% for current national seismic code (ASCE/SEI 7-10) requirements.” This reflects a Seismic Design Category D. Increasing from no seismic to Seismic Design Category B would incur an even lower cost increase.

ACTIONS:

1. By December 1, 2014 identify EERI members involved in seismic design related committees for BSSC / FEMA / ASCE 7 and ICC who are interested in school design code provisions.
2. Disseminate the above policy recommendation /code change issues to the members and solicit comments. Receive comments by January 15, 2015.
3. Incorporate comments and iterate by February 15. Prepare recommendations by March 15.
4. EERI Seismic Safety of Schools Committee, including all the participants in the above process, votes on the recommendations at the EERI meetings at the start of April.
5. Approved recommendations are submitted to the code development committees and organizations by May 1, 2015.

REFERENCES:


NAME OF WORKING GROUP
Seismic Vulnerability of Existing Schools
Task Group #1B

TEAM MEMBERS
Ken Goettel, Rob Jackson, Sissy Nikolaou, Jorge Meneses, Barry Welliver

GOAL STATEMENT
Ensuring that schools are safe for children, staff and visitors is especially important because schools are high occupancy buildings and because society has a strong moral obligation to protect children who must rely on adults for their safety.

WHAT IS THE PROBLEM?
Many older school buildings in the United States are not adequately designed and built to withstand earthquakes and thus pose substantial life safety risks for students, staff and visitors to schools because:

- Building codes for schools have evolved over time and many school buildings nationwide were built decades ago before the development of modern seismic design provisions in building codes. Older schools almost always have significantly less capacity to resist earthquake forces than do newer schools. Thus, older schools often have a much higher probability of damage severe enough to result in deaths and injuries than do newer schools.

- In some parts of the country, including parts of Oregon and Washington and many parts of the Central and Eastern United States, understanding of earthquakes has improved over the decades and locations where earthquakes were thought to be rare events are now known to have significant earthquake threats.

- In some jurisdictions, adoption of the seismic provisions in building codes occurred long after the provisions were updated in the building codes. Also, some jurisdictions may have never adopted codes with seismic provisions.

The earthquake risk for schools is not limited to only California or other areas with the most frequent earthquakes. In many cases, schools in moderate seismic hazard areas (or even low seismic hazard areas) may have seismic risk as high as or even higher than schools in high seismic hazard areas because:

- Many schools in moderate or low seismic hazard areas were built with minimal or even no consideration of earthquakes. Therefore, many schools in moderate or low seismic hazard areas are subject to major damage, up to and including partial or full collapse, from smaller earthquake having much lower levels of ground shaking than are many schools in high seismic hazard areas.

- Enforcement of seismic provisions in building codes and inspections during construction have often been less robust in moderate or low seismic hazard areas than in higher seismic hazard areas.

- The absence of recent earthquake activity in an area can lead to complacency about the risks to older buildings. If there are no “tests” of a building’s lateral capacity from an earthquake, there is a tendency to minimize the need for seismic retrofits. Buildings in low and moderate regions may also see extended life spans which prolong the exposure of these deficient buildings to earthquakes.
WHAT IS THE SOLUTION?

There are three ways to greatly reduce the life safety risk from earthquakes affecting existing school buildings:

- Retrofit buildings to improve their ability to resist earthquake forces. Retrofits may be done at one time, a single-stage retrofit, or may be done incrementally over time. See FEMA document on the Incremental Seismic Rehabilitation of Schools.
- Replace vulnerable buildings with new buildings, designed to current building codes. Replacement may be the best choice when existing buildings have major seismic vulnerabilities, retrofit costs would be high, buildings also have condition issues, are functionally obsolete or otherwise deficient for current needs.
- Abandon existing buildings with high seismic vulnerability, especially for districts with declining enrollment.

There are several key steps in evaluating and mitigating the seismic vulnerability of existing school buildings, including:

- Screen existing buildings to determine which buildings pose the greatest life safety risk from earthquakes. Screening methods include ASCE 41-13, FEMA’s Rapid Visual Screening (FEMA P-154), or the simplified methods (modified RVS) used for the Oregon Seismic Rehabilitation Grant Program or used to evaluate K-12 schools in Washington State.
- Based on the evaluations above, establish priorities for risk reduction measures – one or more of the three approaches listed above.
- Make schools safe by implementing the highest priority risk reduction measures, as funding becomes available from local, state or federal sources.

KEY ISSUES

The most straight-forward and effective solutions are replacement of vulnerable buildings with new, current-code buildings or abandoning them. For new buildings, the seismic design requirements are generally provided by the current building code for a given location and soil condition. For abandonment, the building is no longer used as a school or demolished, so that life safety for schools is no longer an issue.

However, for seismic retrofits, a key issue is what criteria are appropriate for the level of life safety for a retrofitted school building?

- ASCE 41-13?
- ASCE 31-03 / ASCE 41-06?
- Any of the ASCE 41-13 performance levels: risk reduction, collapse prevention, life safety, immediate occupancy, post-earthquake operability?

These criteria are defined by the combination of the performance target(s) and the level of earthquake ground motions (probability or return period) to which the performance target(s) are met.

FOR EXISTING SCHOOLS, KEY ISSUES TO BE EVALUATED INCLUDE:
1. Define suggested (recommended? target? ideal?) performance levels for schools, perhaps separately for schools that are and are not designated as emergency shelters, recognizing that schools not formally designed as emergency shelters have an inherent responsibility to “shelter-in-place” which raises the bar automatically.

2. Do we recognize the lesser retrofits, including risk reduction have benefits and contribute to better life safety without meeting the targets above? Yes?

3. Are there different targets in high, moderate and low seismic hazard areas? For example, is collapse prevention the key issue in lower seismic hazard areas? If lower than life safety performance is adopted, the district and the public they serve must be fully aware of the limits and consequences of lesser retrofits.

4. Is there a cut-off of hazard level for which structural or nonstructural retrofits are not necessary (or only weakly recommended)?

5. Do we address all school buildings or focus primarily on a subset of the most vulnerable buildings: URMs, lightly reinforced RMs, tilt-up concrete, pre-cast concrete, non-ductile concrete moment frame...others(?)

6. What is the relative importance/priority for structural and nonstructural retrofits?

7. Which nonstructural retrofits are most critical? For example, do nonstructural elements such as parapets, chimneys and exterior cladding above high occupancy areas adjacent to the building, heavy partition walls subject to out of plane failure, and tall, heavy contents which pose substantial life safety risk have a higher priority than nonstructural elements such as suspended ceilings (just follow code when they are replaced), lights, short, light bookcases etc.?

8. Costs: to be meaningful and implementable, recommendations for retrofits must include consideration of costs, ideally with economic analyses such as benefit-cost analysis.

**NEXT STEPS – ACTIONS FOR EERI SCHOOLS EFFORT: EXISTING BUILDINGS**

1. Explain the severity of life safety risk in schools better than existing publications in terms understandable to non-technical school staff. For example, for schools that are a collapse hazard in earthquakes with return periods of 500 years to 2500 years (or more), the life safety risk from earthquakes is higher than the tornado life safety risk. In the New Madrid Seismic Zone, the return period for a major earthquake is 10 times shorter than that for an EF2 or greater tornado at a given location.
2. Explain and quantify the benefits of retrofits – not only life safety, but also damage reduction, and reduced loss of function.

3. Explain the importance of higher design criteria for schools designated as emergency shelters and the need for each school to have an explicit policy regarding the use of the building following an earthquake.

4. Provide an understandable introduction to the technical issues listed on the previous page for school district staff.

5. Promulgate the above wisdom via: publications, webinars, workshops……

6. Seek foundation funding for outreach. There are at least several foundation funding efforts to increase resiliency for natural hazards, including the Rockefeller Foundation and Smart Growth America that are heavily involved with HUD’s Disaster Resilience Grant Program. There must be many others.

**NOTE: there are many overlaps with other Task Groups – we need to coordinate/combine with other task group efforts.**
NAME OF WORKING GROUP
Education & Outreach at Schools
Task Group #5

TEAM MEMBERS
Heidi Tremayne, John Aho, Eddie Vega, Lelli Van Den Einde, Thalia Anagnos, Vincente Pericoli, Melvyn Musson

GOAL STATEMENT
By July 2017, EERI’s SSSI will have at least 200 members from 20 Professional & Student EERI Chapters conducting classroom lessons and outreach activities from a selected list of vetted existing, high quality, and standards-based modules at 100 schools across the U.S. to teach about earthquake hazards, engineering principles, and risk reduction practices. These activities will be an entry point for EERI SSSI members to talk to students, teachers, administrators and parents about their seismic safety.

(SMART criteria mapping: Specific, Measurable, Achievable, Relevant, Time Bound)

Success in achieving our goal will be defined as:
● 6 quality, standards-based lessons, 2 for each of the following age groups: high school, middle school, and elementary school
  ○ Quality lessons include material lists, description of activity's alignment to educational standards, lesson plans, supporting materials (powerpoint files, posters, handouts, etc.), and assessment tools.
  ○ Lessons should be standards-based (NGSS, Common Core, and national/state curriculum standards)
● 3 quality outreach activities for use at science fairs, back to school nights, etc.
  ○ Quality activities include material lists, descriptions of activities, training materials, supporting materials (powerpoint files, posters, handouts, etc.), and assessment tools.
● 200 members have conducted classroom lessons or outreach activities
● 20 EERI Professional and/or Student Chapters have conducted local outreach programs or activities
● 100 schools across the US have received classroom lessons or outreach activities
  ○ Activities have reached 25% under-represented minorities, women, etc.
  ○ Activities have reached ~ 5,000 students by 2017
● 50 school safety presentations or handouts provided to teachers, PTAs & Administrators under development as a follow-up to this activity.
● Student Chapters have been linked to Professionals & Professional Chapters through outreach and advocacy to schools (with further measurement methods for this to be developed).
● Plan for long-term sustainability of the program

ACTION PLAN SUMMARY

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Expected Timeline</th>
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<td>1. Establish Working Group for Earthquake Classroom Education</td>
<td>Present - December 2014</td>
</tr>
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<td>2. Finalize ready-to-go lesson tool kit for members to teach students across the country</td>
<td>October 2014 - June 2015</td>
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<td>3. Working Group to advocate adoption of tool kit by several pilot EERI chapters and members, and then support training and local educational program development.</td>
<td>April 2015 – October 2015</td>
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<td>4. Implementation of educational programs and activities by EERI chapters and members (Phase 1)</td>
<td>September 2015 – June 2016</td>
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<td>5. Assessment of educational programs and activities,</td>
<td>May 2016 – October 2016</td>
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improvements to tool kit lessons, and reporting to SSSI

<table>
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<tr>
<th>6. Working Group to advocate adoption of tool kit by additional EERI chapters and members, and support development of local educational program development.</th>
<th>May 2016 – October 2016</th>
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<tr>
<td>7. Implementation of educational programs and activities by EERI chapters and members (Phase 2)</td>
<td>September 2016 – June 2017</td>
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<tr>
<td>8. Assessment of educational programs and activities, improvements to tool kit lessons, and reporting to SSSI</td>
<td>May 2017 – October 2017</td>
</tr>
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**ACTION PLAN DETAILS**

1. **Establish working group for Earthquake Classroom Education**
   a. Identify necessary budget to achieve action plan.
   b. Identify possible costs of pilot launch and necessary funding mechanisms.

2. **Finalize ready-to-go lesson tool kit for members to teach students across the country**
   a. Review existing lessons from FEMA, NEES and others (December 2014)
      i. PLTW lessons from NEES@UCSD
      ii. UC San Diego 6th grade
      iii. nees@berkeley 4th grade lessons
      iv. FEMA for kids lessons that have students survey and identify vulnerabilities (i.e., non-structural, preparedness)
   b. Finalize consistent template and list of documentation needed for all lessons (February 2015)
      i. consider engaging teachers in review of the final lessons
   c. Post lessons in tool kit that can be accessed by EERI chapters (May 2015)
   d. Develop training materials for EERI volunteers about delivery to youth using appropriate concepts, language, etc. (June 2015)
   e. Develop school safety presentation or handouts provided to teachers, PTA’s & Administrators as a follow-up to this activity. (October 2015)

3. **Working Group to advocate adoption of tool kit by several pilot EERI chapters and members, and then support training and local educational program development.**
   a. Outreach to EERI regional and student chapters to solicit interest in pilot chapters
      i. successful pilots will have both strong professional and student chapters in the same region
         1. Goal for 2015 is 2-3 regional clusters that have at least one professional chapter and one student chapter.
   b. Coordinate training and lesson demonstration to interested local chapters
      i. EERI Annual Meeting
         1. GOAL for Training Activity in Boston March 30 - April 2, 2015
ii. Workshop?

iii. At local pilot regions?

iv. In partnership with EERI Student Leadership Council (SLC)?

4. **Implementation of educational programs/activities by EERI chapters and members (Phase 1)**
   a. Consider and promote integration with Shake-Out activities
      i. database of interested members (wanting to do delivery) and match with schools wanting
         Shake-Out participation/expert involvement (collaborate with SCEC on this
         advertisement to local teachers)?
      ii. Align with SCEC and its outreach with QuakeCatcher network.
   b. Consider teacher training and professional development (within district)
   c. The Working Group will likely need to help our pilot regions reach out to schools and find these
      connections. Need to find partners who can help solicit teachers who want visits by experts.

5. **Assessment of educational programs and activities, and improvements to tool kit lessons**
   a. Assessment approaches to consider include:
      i. Surveys to teachers
      ii. Surveys to deliverers (professionals and students)
      iii. Surveys of students (IRB?)
      iv. Use annual meetings, chapter meetings, conference calls to measure progress
      v. National Teacher Conventions - workshops for teachers, i.e. NSTA
   b. Work with pilot chapters to refine lessons based on feedback from Phase 1.

6. **Working Group to advocate adoption of tool kit by additional EERI chapters and members, and**
   **support development of local educational program development.**
   a. Pilot EERI Chapters to train new EERI Chapters on outreach implementation.
   b. Partner with EERI Student Leadership Council (SLC) in recruitment, training, and delivery
   c. Internal Chapter recruitment to maintain sustainability of outreach activities.

7. **Implementation of educational programs/activities by EERI chapters and members (Phase 2)**
   a. Expanding from Pilot to larger groups of chapters.
   b. Planning for sustainability (within chapters, sharing with other educational partners, and also by
      teachers who can self-deliver lessons).
   c. Planning for broader dissemination (if EERI funding or interest declines).
   d. Planning for Equipment Maintenance.

8. **Assessment of educational programs and activities, and improvements to tool kit lessons**
GOAL STATEMENT

Earthquake risk to school buildings needs to be understood by a variety of groups. Making the case for action (mitigation) requires a clear understanding not only of the technical issues but also the economic, social, and political implications of misunderstanding or under appreciating the consequences of earthquakes. EERI is well positioned to be able to contribute to this conversation and provide an authoritative and unified voice for seismic safety for school buildings.

This project would create documents and other tools that will help explain earthquake risk for school buildings to School Administrators, Parents and Design Professionals in understandable language and in a compelling manner.

TEAM MEMBERS

Bill Holmes, Ivan Wong, Barry Welliver, Mike Mahoney, Ayse Hortacsu

BACKGROUND

WORKSHOP OUTLINE (ORIGINAL - modified)

Create “How To Documents” within three years

   a. For School Board Members and Administrators
      i. Awareness document or website
      ii. Explains building code function
      iii. Goal to make decision-makers aware of seismic issues with schools

   b. For Design Professionals
      i. To help communicate risk effectively for use in the decision-making process
      ii. Clarify building code intent for new and existing schools
      iii. Goal to make design professionals effective communicators of school seismic safety issues

   c. For Parents and Community Members
      i. Action steps for communities to effectively move toward seismic safety of schools
      ii. Document and/or website
      iii. Goal to provide tools for effective school seismic safety mitigation actions within communities

POST WORKSHOP DEVELOPMENTS

During the workshop, Mike Mahoney indicated that a new multi-hazard FEMA project for schools was being developed to address some of the communication and documentation issues noted above. This project is now being finalized as a School Safety Guide from a Multi-Hazard perspective whose audience would include school administrators, parents, and potentially the public. The first phase is to develop a state of the art
School Earthquake Safety Initiative

report and initial draft project report. The project objectives include development and dissemination of documents and information that would assist a broad audience on earthquake risk reduction issues for schools. This would seem to be comparable to audiences and items in documents a. and c in the “How To” documents above.

ACTION PLAN DETAILS
(Specific, Measurable, Achievable, Relevant, Time-Bound)

Goal 1: Develop Strategies to Educate and Inform School Administrators, Design Professionals, and Parents about the earthquake risk for schools

- Refine vision and audiences addressed in the School “How To” Documents.
  - Describe and identify the specific needs for each audience
  - Determine how workgroup will relate and interact with the parallel FEMA Multi-Hazard School Safety Guide
- Determine what products will be appropriate for this effort
  - Documents written in “plain” language which convey the need and potential action plan
  - Websites/resources to aid in understanding building earthquake risks
  - Seminars/webinars/template presentations
- Coordinate efforts with EERI Schools Seismic Safety Initiative work groups

Timeline: Spring/Summer 2015

Goal 2: Develop Tools and Documents to help the target audiences understand the earthquake risk and pursue mitigation in communities

- Written documents
- Websites/resources
- Seminars/webinars
- Coordinate efforts with EERI SSSI work groups

Timeline: Fall 2015 – Summer 2016

Goal 3: Conduct Workshops and/or Webinars for school seismic safety advocates

- Design Professionals workshop
  - Understanding Incremental Seismic Rehabilitation concepts
  - Working with Public Officials
  - Understanding the School Facilities Management process
- School Administrators
  - Incremental Seismic Rehabilitation for Schools
  - Working with Design Professionals
  - Working with Seismic Safety Advocates
- Parents and Teachers
  - Working with school districts and legislators
  - Understanding school rehabilitation options
  - Engaging PTA’s and other school organizations
- Coordinate efforts with EERI SSSI work groups

Timeline: Fall 2016-2017
NAME OF WORKING GROUP
Post-Earthquake Evaluation of School Performance
Bonus Activity

TEAM MEMBERS
T.B.D. First draft developed by Heidi Tremayne.

GOAL STATEMENT
Plan and organize response to major earthquakes around the U.S. by a small group of local EERI SSSI members who will conduct reconnaissance that documents the performance of school buildings and their contents, and observes how school performance impacts the community.

The success of this activity will be measured by the creation of an actionable plan, the establishment of members trained to implement the plan after future earthquakes, efficient and timely implementation of this plan after future earthquakes, and modifications to the plan based upon lessons learned from implementation attempts.

(SMART criteria mapping: Specific, Measurable, Achievable, Relevant, Time Bound)

BACKGROUND
The South Napa Earthquake in August 2014, exposed a need to have organized volunteer teams that could self-deploy to document damage and collect data in a strategic way.

The Structural Engineers Association has a similar approach with their Post-Disaster Performance Observation Committee’s (PDPOC) Earthquake Performance Evaluation Program (EPEP) that has a small group of engineers organized and trained to conduct documentation of buildings surrounding seismic strong motion instruments. The EPEP team volunteers who live/work near strong motion stations that recorded high ground motions do a field survey of buildings within a specified radius of the station to document performance. Observations are collected using a unique form that is then shared with all members of the program and can be compiled by a remote organizer. The EPEP observation form was developed to help the group identify and document both good and poor earthquake structural performance under known ground motions.

In a similar way, EERI SSSI could benefit from an organized group of members who are ready to quickly and strategically respond to an earthquake to document the performance of school buildings and their contents, while also observing the how school performance impacts the community. A self-organized group will ensure that ephemeral data is collected before it disappears, and that data gathered is similar across earthquakes so that performance and the effects of mitigation measures can be compared. Additionally, being self-organized, will decrease dependence on EERI staff to coordinate post-earthquake schools investigations as EERI staff will likely be consumed coordinating the overall EERI response to an earthquake.

ACTION PLAN TIMELINE

Year ONE – 2015:

1. Establish a working group committee to lead this effort.

2. Develop a plan for what a 'successful' post-earthquake response would be for school performance.
   a. Recruit members from EERI and EERI’s SSSI to develop the plan.
b. Review reconnaissance best practices (i.e. EERI LFE, SEAOC PDPOC EPEP)

c. Identify what types of information and data needs to be gathered to document school performance and impacts

d. Identify key local stakeholders to contact who could provide information, access, etc

e. Identify tools and procedures to collect the desired information and data, based upon reconnaissance best practices and in collaboration with the EERI LFE committee.

f. Develop a call-down procedure and a decision tree that identifies when to deploy.

g. Explore partnerships with groups that can help create and implement this plan.

h. Develop a pilot training program to train members on data collection tools and procedures

i. Identify funding sources as needed to support this plan.

3. Respond as needed to major U.S. earthquakes per the action plan with materials and strategies available to date

Year TWO – 2016:

1. Develop and implement a training & recruitment program
   a. Consider collaboration with other EERI reconnaissance training efforts.
   b. Develop an pilot training program with materials and tools
   c. Implement the pilot training program
   d. Improve the program based on lessons learned from pilot
   e. Advertise and implement a broader training and recruitment program capitalizing on the geographic spread of EERI regional and student chapters

2. Respond as needed to major U.S. earthquakes per the action plan with materials and strategies available to date

Year THREE – 2016:

1. Implement and refine training & recruitment program as needed

2. Respond as needed to major U.S. earthquakes per the action plan with materials and strategies available to date