



## Creating an Advocacy Network for improved School Earthquake Safety

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### **Abstract**

The Earthquake Engineering Research Institute's School Earthquake Safety Initiative (SESI) is a collaborative network of diverse, expert, and passionate professionals who are committed to creating and sharing knowledge and tools that enable progressive, informed decision making around school earthquake safety. Its goal is to leverage EERI's extensive expertise and reputation to conduct regionally appropriate actions that make a tangible and positive difference in communities around the world, by protecting the lives of all who inhabit school buildings. This paper discusses various approaches, models, and templates that SESI and its members have used to advocate for improved school earthquake safety in their own communities.

Advocacy efforts related to tsunami mitigation [1], classroom education, and building safety screening for schools are shared, with a focus on how these activities have been implemented in the United States but also how they could be modified for use in other countries and regions. Equipment and lessons used to teach school children and teachers about earthquake engineering and earthquake safety are shared along with follow-up activities designed to leverage classroom education into conversations about broader school seismic safety issues with teachers, parents and school administrators. Several building safety screening best practice case studies for school districts document procedures and approaches that can be implemented in other locations to support mitigation programs. Links to all resources and templates are included so that the activities and actions described easily can be replicated or expanded to others who want to enhance school seismic safety in their own communities.

*Keywords: school seismic safety, advocacy, mitigation*



## 1. Introduction to EERI's School Earthquake Safety Initiative

### 1.1 EERI's School Earthquake Safety Initiative

The School Earthquake Safety Initiative (SESI) is a global and collaborative network of diverse, expert, and passionate professionals committed to creating and sharing knowledge and tools that enable progressive, informed decision making around school earthquake safety ([2] and [3]). SESI's vision is to serve the world as a leader in the science, public policy, and advocacy of school earthquake safety. It is an initiative of the Earthquake Engineering Research Institute (EERI). SESI serves stakeholders in school earthquake safety, from children and their parents, to teachers and administrators; from developers and architects, to engineers and builders; from financial institutions and building officials, to government agencies and emergency managers; from civil servants and commissioners, to local politicians and state and federal legislators. EERI leverages its extensive expertise and reputation to conduct regionally appropriate actions that make a tangible and positive difference in communities around the world, by protecting the lives of all who inhabit school buildings.

### 1.2 Background: The Importance of Safe Schools

“Schoolchildren have a right to learn in buildings that are safe from earthquakes” – NEHRP ACEHR [4]

In seismically active regions throughout the United States, thousands of students and staff unknowingly study and work in structurally vulnerable school and university buildings. Non-ductile concrete school buildings, which are prone to catastrophic collapse, are common in many regions that are capable of generating damaging earthquakes. Unreinforced masonry (URM) and under-reinforced (nonductile) concrete were commonly used in school construction in many parts of the United States, especially during the early to mid-twentieth century. 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.

Public school buildings 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 developmental stage and are dependent on adults to provide safety. Adults are presumed capable of consenting to and accepting risks.
- School buildings in many communities 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 (sometimes unfounded) expectation that schools will provide community shelter or host public services in the wake of a natural disaster [5].
- Schools provide de facto daycare for children, thus school closure after earthquakes limits the ability of parents to go to work, an essential part of community recovery.
- School buildings often have large assembly rooms (e.g., gyms, auditoriums), with increased seismic vulnerability, making them more likely to be damaged 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.
- Certain types of damaged school buildings (URMs) cannot be occupied after an earthquake, even as a temporary shelter, due to their susceptibility to further damage or collapse from aftershocks.

Many factors complicate the issue of school earthquake safety. One factor is that 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. Another factor is that 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, including parts of Oregon and Washington and many parts of the Central and



Eastern United States. 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) [6].

The earthquake risk for schools is not limited to California and regions with the most frequent earthquakes. In many cases, schools in moderate or low seismic hazard areas may have high seismic risk because:

1. They were built with minimal or even no consideration of earthquakes. Therefore, such schools are subject to major damage, up to and including partial or full collapse, from a smaller earthquake.
2. 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.
3. 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.

For these reasons, school earthquake safety practices must be regionally appropriate. In low to moderate seismic regions, this may mean that approaches to earthquake safety must be a part of a larger safety discussion for all natural hazards. 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 underappreciating the consequences of earthquakes. EERI is well positioned to be able to provide an authoritative and unified voice for earthquake safety and resilience of school buildings. In summary, earthquake safety for schools can and will mean different things to different groups. It is the intent of this initiative to help communities and school districts decide which risks are acceptable, and to provide the tools and resources to help properly evaluate and mitigate those risks.

### 1.3 Development steps to create SESI

SESI formally launched at the EERI Annual Meeting in 2015 after a year of careful planning. Table 1 summarizes the accomplishments and milestones in SESI since its inception.

Table 1 – SESI Development Milestones

Spring 2014	Exploration phase launched by EERI to plan a retreat to brainstorm and consider development of a School Safety Program for EERI
May-June 2014	Pre-retreat Best Practice Sharing Webinars
July 2014	Planning Retreat held at 10NCEE in Alaska
Fall 2014	Calls to develop Strategic Action Plan & Subcommittee
February 2015	SESI Executive Committee established at Workshop in Oakland to refine Mission, Goals, and Action Plan for 2015
Spring 2015	Proposal written to acquire EERI funding to promote year 1 activities for SESI
April 2015	SESI Launch at EERI Annual Meeting in Boston during Plenary Session & Committee Mtg
May 2015	Funds awarded for 2015 SESI Activities and 5 subcommittees
Jun-Dec 2015	Executive & Subcommittee calls and various activities
Nov 2015	Development of 2016 Priorities and exploration of funding opportunities at SESI Exec. Comm. Meeting in Oakland
April 2016	Publication of 2016 Action Plan. Launch of SESI email group.

### 1.4 Scope of SESI

SESI is an effort primarily conducted by volunteers. Thus, early in its establishment, a focused and narrowed scope was created to target activities and actions into achievable areas where change is most possible with a reasonable assessment of volunteer time. The initial focus of SESI is on school buildings in the US, but the



network hopes to expand in future years to have impact internationally. The SESI scope is currently defined by the following principles that the initiative will continue to build upon and revise as this effort grows and matures:

1. Earthquake and earthquake related hazards (shaking, tsunami, liquefaction, landslides, etc.) will be the primary hazards addressed in this Initiative.
2. While all schools are important, efforts will be focused on schools in high and moderate seismic hazard regions and for events that have a higher probability of occurrence.
3. Schools will be broadly defined to include public, parochial, charter, state, and private schools from pre-kindergarten through university level, however the initial focus will be on K-12 public schools.
4. The stakeholders engaged will depend on the activities of each subcommittee, however the initial focus will be on knowledge transfer and outreach to: state agencies, school administrators, code development committees, legislators, teachers, students, and parents.
5. EERI's SESI advocates for mitigation of earthquake risk to children in existing schools via building retrofit, abandonment, or replacement, as well as nonstructural retrofit.

### 1.5 Organizational structure

SESI is led by a Chair and an invitational Executive Committee of 10-15 members who guide and make decisions for the Initiative. All members of SESI, including the leadership group, belong to the Program Committee whose membership is quite diverse as it is open to any EERI member and has no limit to its size (Figs. 1 – 3).

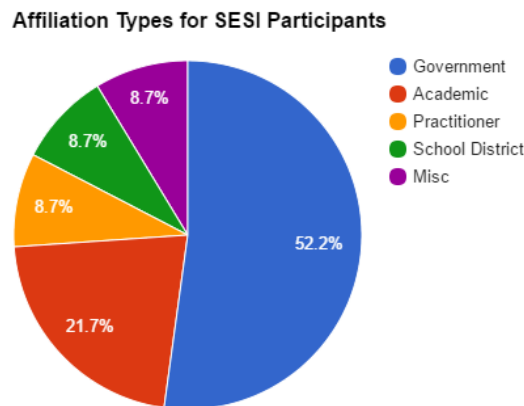


Fig. 1 – Professional affiliations of SESI’s 105 members (as of April 2016).

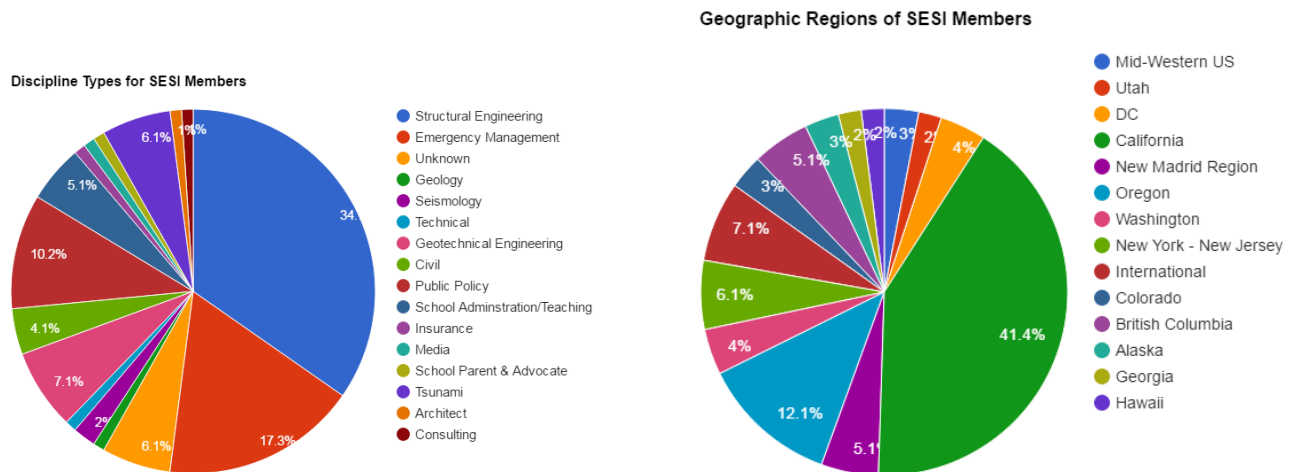


Fig. 2 – Disciplinary backgrounds of SESI Members.

Fig. 3 – Geographic location of SESI members.



The committee engages with its 100+ members that span across the United States and abroad via email and webinars. The program committee is designed in this fashion to allow any EERI member to learn more about the Initiative, its activities, and find ways to participate. The work of SESI takes place primarily at the subcommittee level. Each of its subcommittees have chairs that are tasked with specific charges:

1. Safety Screening, Inventory, and Evaluation Subcommittee: Facilitate and encourage implementation of risk reduction measures by developing and helping to carry out stepwise screening methodologies to identify school buildings with the highest seismic risk efficiently while minimizing the effort and expense for school districts.
2. Classroom Education and Outreach Subcommittee: Use education in the classroom to create an ongoing dialog with parents, teachers, and administrators and to develop advocates for earthquake school safety. Bring together EERI regional and student chapters to collaborate on delivering the activities and serving as expert resources for stakeholders.
3. Tsunami Mitigation for Schools Subcommittee: Support schools with tsunami hazard by provide them access to experts and sharing best practices for tsunami risk mitigation.
4. Code Updating and Improvements Subcommittee: Advocate for code improvements, refinement and/or implementation practices that will enhance school safety and use after major earthquakes.
5. Safety Advocacy and Messaging Subcommittee: Bridge the communication gap between technical professionals and non-technical stakeholders interested in earthquake risk reduction for schools.

The work of several of the committees is discussed in the following sections along with some other major efforts of SESI. The activities of the Tsunami Mitigation for Schools Subcommittee are intentionally excluded because they are described in a companion paper in the 16WCEE proceedings [1].

## **2. Safety Screening, Inventory, and Evaluation of Schools Subcommittee Activities**

The Safety Screening, Inventory and Evaluation of Schools subcommittee aims to facilitate and encourage implementation of risk reduction measures by developing and helping to carry out stepwise screening methodologies to identify school buildings with the highest seismic risk efficiently while minimizing the effort and expense for school districts. The first step in any seismic risk reduction process is to *know* that there is a seismic risk. The Screening subcommittee was developed to help stakeholders gain this knowledge and awareness about their school buildings. This knowledge can be best gained through seismic screening and evaluation of school buildings. To assist stakeholders evaluating their buildings' seismic risk, SESI wants to increase the number and quality of Rapid Visual Screenings (RVS) and Inventories of schools across the nation.

FEMA 154 *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook Third Edition* has proven to be one of the simplest and more effective methods for quickly and easily identifying at-risk structures with minimal costs. Rapid Visual Screening (RVS) 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. Therefore, the Screening subcommittee is actively advocating and engaging its members to conduct RVS screenings and inventories of schools across the US.

### **2.1 The Vision of the Safety Screening Subcommittee**

This subcommittee aims to engage EERI members and local and student chapters around the nation to advocate for and conduct RVS and inventories of schools at a regional level. Schools include K-12 schools, colleges, and universities, however it is acknowledged that their characteristics as well as mitigation approaches and mechanisms are different and should be tracked separately. Empowering geographically diverse groups or local EERI chapters and members can customize the approach for local regional culture, conditions, and characteristics. This will also include establishment of regional priorities and focus areas, including whether to concentrate on K-12 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 help produce a nation with safer schools.

Local EERI teams would advocate the need for RVS to stakeholders, provide professional oversight to RVS efforts, coordinate RVS data collection activities, and offer participating engineers professional development hours. The Screening subcommittee would ensure that these local teams meet to share progress and best practices throughout the year, so that the efforts are aligned. 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 US examples; and (5) Resources, i.e. Applied Technology Council (ATC) and National Earthquake Technical Assistance Programs (NETAP) 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.

## 2.2 Documentation and Dissemination of Best Practices

In order to fulfill its goals of aiding schools evaluate their seismic risk, the Screening subcommittee is aiming to produce a product that documents existing school screening programs and provides guidelines and recommendations to new advocates of seismic safety based on these evaluations. Case studies are being conducted of seismic screening programs across the US to document best practice school screening and inventory programs that showcase diversity of scope and scale, as well as tools and resources used. The Screening subcommittee will then develop a companion document based on these examples to provide clear recommendations that are aimed at helping new school earthquake safety advocates make good decisions and understand the many variables in a screening program as they consider and develop appropriate methods for their unique situation. The Screening subcommittee has shortlisted the safety screening programs found in Table 2. Once the committee conducts these case studies, it will produce recommendations and develop a dissemination strategy to promote and share with state departments, school districts, school administrators, and EERI members.

Table 2 – Best Practice Case Studies of Seismic Screening & Retrofit Programs by State

State	Seismic Safety Screening and/or Retrofit Program
Alaska	The Kodiak Island School District Pilot Project (screening and retrofit)
Alaska	RVS of Kenai Peninsula Borough Schools (screening and recommendations)
Alaska	Matanuska-Susitna Screening Pilot Program (screening)
California	San Francisco Private Schools Mandatory Evaluation Ordinance (policy)
California	Piedmont District Schools (screening and retrofits)
Oregon	Oregon Seismic Rehabilitation Grant Program
Oregon	Portland School Building Improvement Bond
Oregon	Beaverton School District Resilience Bond
Utah	Utah Schools Pilot Study (screening)
Washington	Washington School Seismic Safety Pilot (Aberdeen and Walla Walla screening)

## 3. Classroom Education and Outreach Subcommittee Activities

### 3.1 Background

The Classroom Education and Outreach Subcommittee is tackling the problem of school safety from a grassroots approach, with the goal of using education in the classroom to create ongoing dialog with parents, teachers, and administrators thereby developing advocates for earthquake school safety. As has been demonstrated with the



*Great Southern California ShakeOut* and the *Dare to Prepare* campaign, consistent and simple messaging is an effective way to help the public understand how to be safe in an earthquake and to take action to prepare for future events [7]. The SESI Classroom and Outreach Subcommittee plans to use a similar approach to help students, teachers, administrators, and parents become aware of the seismic risks in their schools.

### 3.2 Curriculum and Implementation

K-12 engineering curriculum aligned with standards that come with well-defined documentation and can be easily taught to a range of teachers for broad dissemination have been developed for 4<sup>th</sup> grade and high school physics classes. Both the 4<sup>th</sup> grade and high school curricula lead students through hands-on and research activities to learn basic earthquake engineering design principles such as the effects of earthquake-resisting elements like diagonal bracing and shear walls. They make use of an electronic instructional shaking table that tests structures under representative earthquake loading. The 4<sup>th</sup> grade project requires students to build K'Nex<sup>TM</sup> buildings, while the high school physics project consists of two-story balsa wood structures and integrates mathematical predictions into a design competition. Both curricula have been related to numerous California State Standards and Next Generation Science Standards (NGSS) [9] in the area of earth sciences, mathematics, and engineering design. Details of the curriculum can be found in [8].

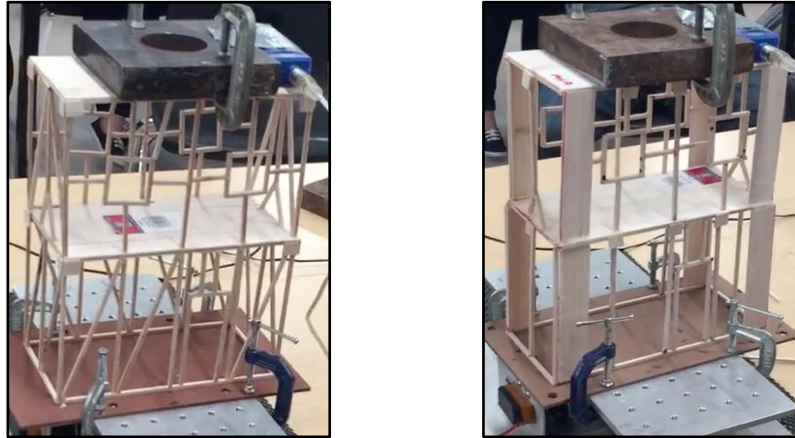
Student outcomes for both curricula are similar. Upon completion of the projects, students will learn that earthquakes are a natural hazard and engineers help design buildings to reduce damage; discover what building elements affect building stability; generate and compare multiple solutions to enable a model building to resist shaking; understand that study of failure mechanisms can be used to improve design; experience the engineering design process, including defining design problems, using fair tests to collaboratively produce data; compare alternate solutions with design criteria; and communicate evidence-based recommendations.

**4<sup>th</sup> Grade Curriculum:** The 4th grade curriculum is accomplished with two 90-minute lessons. The first session introduces earthquakes, the engineering process, and design elements which are then tested by the students to develop ideas for strengthening buildings. Scaffolding is provided through visuals of vocabulary and demonstrations, using a “say it/show it/write it” approach for instructions, and sentence framing on the worksheets to help students focus on key observations and develop background knowledge. The second 90-minute lesson provides students with the challenge of designing an earthquake-resistant building and presenting their data to make a group decision about selecting among different approaches to reach a design solution. Students work collaboratively in six design teams, to learn structural engineering vocabulary, define specific criteria and limitations for an earthquake-resistant building, test and refine their designs, collect data, and communicate their findings. Fig. 4 shows the 4th grade K'Nex structures being tested. Scaffolding is provided through review of vocabulary for design elements using actual building materials, visual and verbal review of the results of the design element testing, group work on design challenges and conclusions, prompts for team work and evidence-based conclusions, and guidelines for discussion.



Fig. 4 – Students testing K'Nex<sup>TM</sup> structures on an electronic shaking table at the NEES@Berkeley labs

**High School Curriculum:** The high school SESI curriculum begins with preliminary concept lectures, demonstrations utilizing a small instructional shaking table, and a concept research assignment. Furthermore, it features the design, construction, analysis, and testing of a balsa model structure (BMS). Specifically, the students retrofit a BMS to include a lateral force resisting system (LFRS) that includes the use of diagonal bracing, shear walls, and gusset plates. After constructing their model, students are tasked to predict its dynamic behavior. These predictions are compared to the observed behavior when their BMS is tested on an instructional shaking table under three earthquake records of increasing intensity (Fig. 5). The curriculum is designed to include four 60 minute visits to the high school classroom by EERI student chapter and local professional members. The project has been developed as a team competition where students optimize their design to achieve the highest performance index (PI). Details can be found in [8].



a) Diagonal Braces as LRFS

b) Shear Walls as LRFS

Fig. 5 – Balsa structures being tested on instructional shake table

#### 1.4 Broad Implementation of EERI SESI Curriculum

EERI is a membership organization that draws from its nearly 3,000 members to achieve its mission of reducing earthquake risks. This SESI classroom outreach program provides a way for members to share their expertise and enthusiasm with members of the public. It utilizes the existing members of both EERI Student Chapters [10] and EERI Regional Chapters [11] to complete lesson delivery in their region. As of January 2016, EERI has more than 60 student chapters at universities in the US and around the world, and 13 regional chapters located in the US. Membership in EERI Student Chapters consists primarily of civil and geotechnical engineering students obtaining undergraduate, masters and PhD degrees. The regional chapter membership consists of professional engineers, geoscientists, architects, planners, public officials, and social scientists, who work as researchers, practicing professionals, educators, and government officials—all focusing on earthquake risk reduction.

The goal of engaging existing EERI chapters in delivering these lessons is to use chapter internal organizational structures and annual leadership transfer to facilitate the sustainability of this outreach program over time. Furthermore, teaching K-12 students about earthquake engineering concepts should reinforce the knowledge and skills of participating university students and young professionals. This was demonstrated in a study of student ambassadors delivering K-12 tsunami engineering outreach lessons for the NEES program. Ambassadors experienced gains in professional skills such as teamwork, time management and oral presentations; expressed an increase in their self-perception as skilled leaders; and reported increased confidence in their ability to succeed in engineering [12]. The goal of partnering student instructors with professionals is to enhance the networking and knowledge of participating university students while also providing school teachers and administrators access to experts in earthquake risk reduction.



## 4. EERI Policy Statements about School Earthquake Risk Reduction

### 4.1 School Policy Statement Development and Approval Process

In Fall 2015, EERI's Public Policy and Advocacy Committee encouraged SESI to participate in its development of policy position statements by drafting statements about school earthquake safety. The purpose of the position statements is to clearly define policy concepts for which EERI should advocate. The statements, which will be developed over time into an EERI comprehensive policy agenda, aim to cover a range of issues, from broad concepts to specific calls for legislative action, primarily in the US. The position statements will be used (1) for advocacy among lawmakers and the media, both in the immediate aftermath of damaging earthquakes and on an ongoing basis; (2) to help EERI determine positions on pending legislation; and (3) to post on the EERI website.

After a workshop in December 2015 that reviewed 15 potential policy statements for EERI, five statements were prioritized for finalization by Spring 2016, including both SESI statements. EERI used a thorough voting process to approve the final statements by the Committee and EERI Board. The SESI statements were supported by a strong majority and will be posted by June 2016 on the EERI website [13]. Each statement includes a 1-page summary of the position, and a 4-page companion white paper with additional supporting information and justification for the position.

### 4.2 Statement 1 - Schools shall be URM FREE BY 2033

During the early to mid-twentieth century school buildings were commonly constructed out of unreinforced masonry (URM) in the United States. This structural type has inherent, life-threatening vulnerabilities to earthquake ground shaking. URM buildings have collapsed or suffered major damage in numerous earthquakes in the US and throughout the world, leading to many casualties. In particular, the risk posed by school buildings was brought to public attention in the 1933 Long Beach earthquake in southern California where more than 230 URM school buildings were either destroyed, suffered major damage, or were judged unsafe to occupy following the earthquake (refer to Figs 6 and 7) ([5] and [11]). Since then, many communities have identified their URM schools and either retrofitted or replaced them. However, more than 80 years after this earthquake, many school children in the US still attend school in these dangerous buildings.



Fig. 6 – Jefferson Jr. High School in Long Beach, California, destroyed by the March 11, 1933 earthquake [15].



Fig. 7 – View of John Muir School, showing damage from the March 10, 1933 Long Beach earthquake. Located on Pacific Ave. in Long Beach, California. Photo taken on March 18, 1933 (photo: W.L. Huber) [15].

SESI's position statement is "To keep students safe, school buildings should be 'URM free by 2033' in regions with high and moderate earthquake hazard." This statement was developed and expanded from the concept originally developed by Wolf and Wang [5]. The statement encourages legislatures, school districts, and school boards in regions with high and moderate earthquake hazard to act by:

1. Establishing programs to identify URM school buildings and prioritize them for retrofit or replacement.
2. Establishing funding mechanisms, financial assistance, and incentives to finance the retrofit or replacement of URM school buildings.
3. Establishing fully-funded programs at the state, regional, or school district levels to set criteria and standards, allocate funding for school retrofit and replacement projects, and ensure quality compliance of all retrofit or replacement projects for schools.
4. Requiring structural upgrades to or replacement of all actively used URM school buildings in US regions with moderate and high seismic hazard by 2033, the 100-year anniversary of the Long Beach Earthquake.

It is important to note that other hazardous types of school buildings exist beyond URM buildings (i.e., non-ductile concrete buildings), which should also be retrofitted or replaced. The importance of mitigating all vulnerable building types through retrofit or replacement is clearly stated in the Western States Seismic Policy Council's Policy Recommendation 13-10 (soon to be updated to 16-10) titled "Joint Policy for the Evaluation and Seismic Remediation of School Buildings," which is also supported by EERI [16].

#### 4.3 Statement 2 - Mitigation of Nonstructural Hazards in Schools

Nonstructural hazards pose a great risk to students, staff and visitors in schools during earthquakes. Nonstructural items like ceiling tiles, light fixtures, bookshelves, file cabinets, computer monitors, projectors, vending machines, chimneys, parapets, large windows, and other items can fall and injure or kill occupants and block safe building egress. This has been shown in many US and international earthquakes, most recently in the August 2014 South Napa Earthquake in California [18], where injuries and deaths of students from these hazards has been narrowly avoided because the earthquakes occurred outside of school hours. For example, in the 1994 earthquake in Northridge, California, light fixtures weighing up to 80 pounds each fell on students' desks in approximately 100 classrooms. Had the earthquake occurred during school hours, many students would have been injured [19].



Fig. 8 – Lights fell onto desks in a Northridge Junior High classroom during the 1994 earthquake. School was not in session, so no injuries occurred (photo: Gary L. McGavin) [19].

Nonstructural items that can pose a falling safety hazard to students include, but are not limited to, ceiling tiles/materials, light fixtures, chimneys, parapets, and large windows. Many of these items can fall with great force during earthquakes, and often can limit or prevent safe building egress. Nonstructural mitigation for many items is inexpensive and can often be completed by facility staff or volunteers [17]. This is an easy first step for schools to take when working to identify, prioritize, and mitigate their earthquake risks. However, mitigation for some building elements, such as parapets and chimneys, is more expensive and generally requires technical expertise.

SESI's position statement is "Students should be kept safe from injury by nonstructural items in school buildings in regions with high and moderate earthquake hazard." The statement encourages legislatures, school districts, and school boards to act by establishing programs to identify, prioritize, and mitigate nonstructural hazards in schools, establishing funding mechanisms, financial assistance, and incentives to finance mitigation of nonstructural hazards, and requiring nonstructural anchoring and bracing of potential falling hazards to ensure safe egress from schools after earthquakes.

#### 4.4 Other Policy Topics for Future Advocacy

The two statements developed by SESI so far are not the only items schools need to improve their earthquake safety. SESI also believes it is important for school administrators and policy makers to also consider the following actions that can also improve school safety after future earthquakes:

- Creating community resilience plans that align and prioritize mitigation efforts
- Requiring adequate building codes for existing and new schools with enforcement and inspections
- Providing and publicizing public access to the status of seismic school safety, including vulnerable building databases, hazard information for schools, and other resources
- Screening to assess the integrity of school buildings
- Identifying areas of possible exposure to tsunami inundation, liquefaction-prone areas, landslides, and possible dam failures.
- Retrofitting or replacing school buildings vulnerable to earthquake hazards, and tracking and reporting on the progress.
- Checking of utilities and other systems important for rapid recovery after earthquakes.

While policy statements alone will not solve the risk to school children, having statements endorsed by SESI and the EERI leadership shows the importance of school earthquake safety to the organization and broader earthquake risk reduction community. Future efforts to advocate for public and government support of these statements and their recommended actions are being considered and planned as future ways that SESI can activate its membership towards its mission of 'promoting safe buildings for school children'.



## 5. Conclusions and Next Steps

In 2016, the SESI Program is focusing on seeking funding for ongoing SESI operations and initiating activities to support solicitation of funding, and outreach to current SESI members and participants via the Program Committee to increase their involvement. A new email announcement system and webinar series was launched in spring 2016, to keep participants and EERI members more informed about SESI's progress in advancing and advocating for improved school earthquake safety. A webinar series will highlight new work on school safety measures in the United States and will be broadcast to the general membership and program committee. Additionally, the program will finalize the SESI working products including screening case studies, curriculum, and guidance documents. This will include updated resource materials on the SESI website and working with regional and student chapters of EERI in distributing to local communities. Since there are a large number of schools participating in Shake-Out, the program will also develop and propose suggested Shake-Out Plus One activities such as non-structural classroom hunts and other means to extend the traditional Drop, Cover, and Hold activity. Finally, the program will focus on outreach to the stakeholder community and building the community of school earthquake safety advocates by working with regional and student chapters of EERI.

As SESI continues to build its membership and activities, we will reach out and collaborate with the international community as partners and seek to learn from and contribute to such significant efforts as the United Nations Office for Disaster Risk Reduction (UNISDR) World Initiative for Safe Schools (WISS) [21]. We are encouraged by the strong support we have received from the professional community for safe schools. This is truly one area where professional expertise can be effectively used to educate communities about the need to proactively consider the safety of children, staff, and the public in all school facilities.

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