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Improving the Earthquake Safety of Ghana's Schools

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Abstract

This paper describes a project undertaken by the 2012 Housner Fellows of the Earthquake Engineering Research Institute (EERI) to improve the earthquake safety of schools in Ghana. Ghana's history of moderate, infrequent earthquakes has led to a perception of low seismic risk and a general lack of preparedness for the consequences of a probable major seismic event. Historically, earthquakes with magnitudes up to 7.1 have occurred in the more densely populated south of the country and with no legislation regarding building codes, any major event could set the country back in its development by many decades. Ghana, like many developing countries, is faced with the challenge of a lack of trained manpower and ensuring the earthquake safety of school children, on whom its future depends, is essential.

A proposal by the Government of Ghana to build 200 new Senior High Schools during the years 2013 to 2015, presented an ideal opportunity to introduce comprehensive seismic safety measures regarding the schools. Most Senior High Schools in Ghana are commissioned by the government and the project was executed by partnering with the Architectural and Engineering Services Ltd (AESL) a consulting firm wholly owned by the government of Ghana which is responsible for overseeing standard designs for government schools. A partnership was also formed with the National Disaster Management Organization (NADMO) to teach earthquake preparedness to schools.

The project sought to:

• Expand knowledge of the seismic hazard in Ghana

• Improve current practices for the design and construction of new schools, and increase the safety of existing schools

• Promote the teaching of earthquake preparedness to school children and teachers, as well as the general public

The project examined current practices for school design and construction in Ghana and the seismic hazard that buildings within Ghana must resist. With a focus on buildings within the capital city of Accra earthquake-resistant measures for the architectural and structural design of new schools were identified.

Key amongst the findings of this project was the need for a probabilistic seismic hazard analysis to be carried out for the country, and a legally binding seismic code to be adopted. The following were also produced as part of the project report:

• An approach to evaluating and improving the safety of existing schools

• Methods of teaching students and teachers about earthquakes and protective responses

• An identification of stakeholder groups and a discussion of ways in which they could advance school seismic safety.

The main achievement of this project was that it produced a comprehensive outline of processes required for relevant stakeholders to undertake to achieve the desired results.

Key Words: *Keywords: School; Children; Safety; Earthquake, Ghana*

1. Introduction

A project to improve the earthquake safety of schools in Ghana was undertaken by the inaugural class of Housner Fellows of the Earthquake Engineering Research Institute (EERI). The two year Housner Fellows Program was introduced by EERI in 2012 with the objective of developing the next generation of leaders in earthquake risk reduction. The program was made possible through a substantial gift to EERI from Professor George Housner, a founding member of EERI, who was an educator and leader in earthquake engineering. The program received additional support from the Federal Emergency Management Agency (FEMA) and the Global Facility for Disaster Reduction and Recovery (GFDRR) of the World Bank which supported the participation of three of the Fellows.

As part of the Housner Fellows Program, the Fellows were required to undertake a group project. The Fellows chose to undertake this project because it had significant potential to help reduce seismic risk. The 2012 Class of Fellows was made up of six engineers, one geologist and one architect. This allowed the Fellows to take a holistic, multidisciplinary view of seismic safety issues by engaging with a wide cross-section of key Ghanaian school stakeholders during their trip to Ghana.

Ghana is a developing country located within West Africa. It has a population of about 25 million people and since 1993, it has been a constitutional republic, with an elected president and a multi-party parliament. Basic school education in Ghana takes 11 years (two years of kindergarten, six years of primary school, and three years of junior high school). After basic school, students may enter Senior High School (SHS) for a three-year course, which prepares them for university education. While there are a number of privately owned and operated schools at all levels most Senior High Schools are public schools. In order to significantly increase access to higher education, the Government of Ghana decided to construct 200 new Senior High Schools

The Fellows found that by collaborating with the Architectural and Engineering Services Limited (AESL), a consulting firm wholly owned by the government of Ghana, they had a unique opportunity to influence the design of the new schools being commissioned by the government. The AESL holds a strategic position in the delivery of new school buildings and the rehabilitation of existing buildings in Ghana. The AESL is responsible for overseeing standard designs for public schools. These designs are also used by non-governmental agencies and other bodies for school buildings. The AESL adopts an approach to design in which standard school block designs are adapted to local site conditions. The inherent repetition of the standardized buildings, offers the advantage that any improvements made to the design standard will improve all future schools based upon it. The AESL is also often called upon for advice on the rehabilitation of existing school buildings.

School buildings have been recognized internationally for their critical function to protect students and teachers during an earthquake and provide places of refuge for the community after an earthquake. In the past decade, tens of thousands of children have lost their lives in earthquakes as a result of collapsed school buildings [2]. Improving the earthquake safety of schools often requires governments, school officials, families, communities, engineers, and scientists to work together. The process creates awareness amongst the community thus making it easier to extend the principles to other areas. Improving the earthquake safety of schools is thus often the first step taken to build earthquake resilience of a community as a whole.

The project began with a period of research on the topic. During this period, the Fellows reviewed standard school plans and the most current seismic design building code for Ghana. The period of research was followed by a visit to Ghana by the Fellows in late August 2013. While in Ghana, the Fellows met with several stakeholder groups including the AESL, The National Disaster Management Organization (NADMO) and the Ministry of Education. Visits were facilitated by the Ghana Institution of Engineers (GhIE), the licensing body and professional organization for practicing engineers.

The final phase of the project involved a synthesis of information gathered and preparation of a report detailing the findings and recommendations. Throughout the project period, the Fellows held regular conference calls amongst the group and engaged in correspondence with local stakeholders. The Fellows were assisted by a review committee of relevant experts who examined their findings.

In the following sections, the earthquake hazard in Ghana is examined. Current practices in the design and construction of new school buildings are also discussed. Recommendations to improve the earthquake safety of new school buildings are then made. The paper further considers ways in which existing schools may be evaluated and how to ensure earthquake preparedness for students and teachers. The paper ends by proposing ways in which various stakeholder groups may assist in the task of ensuring school seismic safety

2. Ghana's Earthquake Hazard

An understanding of the earthquake hazard in Ghana was required in order to determine the level of ground shaking that school buildings may undergo. Information on the level of earthquake ground motion to be expected at various locations of a country is normally obtained through a seismic hazard assessment. Seismic hazard maps are produced from the assessment and they form an important part of building codes.

Seismic hazard maps presented in seismic codes for Ghana have so far been deterministic in approach. They have been based on the maximum responses expected from identified sources. Unfortunately, deterministic methods are unable to account for uncertainties such as those associated with the location of sources or the maximum possible earthquake that can be associated with a source. There is also no literature available to provide information on the assumptions made in producing the maps. It was therefore necessary to obtain an understanding of the factors that could influence seismic hazard maps for Ghana.

2.1. The Seismicity of Ghana

Ghana is a region of low to medium seismicity. It's record of earthquakes dates back to 1615. The record includes a number of earthquakes with magnitudes between 4.0 and 5.0 and many more with magnitudes of 3.0 or less [3]. Whilst several records of seismic activity could be found in the southern part of the country, the north of the country remained fairly quiet [4]. The most significant earthquakes occurred near Accra in 1862 and in 1939 [5]. In 1862, a magnitude 7.1 earthquake caused great damage, even to the most-strongly built stone masonry houses [6],[5]. Most public buildings were rendered unusable and three people were killed [5]. The 1939 Accra earthquake was a magnitude 6.5 earthquake [6] with peak ground accelerations from 0.14g – 0.57g [10]. It caused widespread damage to adobe houses as well as better-constructed buildings. Twenty-two people were killed [5].

2.2. Geology and Tectonics

Ghana is situated far away from any tectonic plate boundary, but the southern part of the country has two major tectonic features which have contributed to most of the seismic activity the country has experienced [3]. A study of the geology and tectonics of the region reveals that seismic events have been caused by normal faulting in the coastal area and the NNE-striking Akwapim thrust system [4]. These tectonic features have been named as the Coastal Boundary Fault and the Akwapim Fault Zone respectively [5] (Fig 1). Both are still currently seismically active and the Akwapim thrust system, which is believed to be in its juvenile stage, may become much more active in future [7].

2.3. Characterizing the Earthquake Hazard of Ghana

The earliest known attempt to characterize the seismic hazard in Ghana was presented in the 1988 Draft Ghana Building Code. The Code included a seismic hazard map that divided the country into four zones with peak ground accelerations of 0g, 0.02g, 0.04g and 0.08g for zones 0, 1, 2 and 3, respectively. The next revision of the seismic hazard map was published in the 1990 BRRI Code for the Seismic Design of Concrete Structures [8]. In this revision, the country was again divided into four zones but the peak ground accelerations assigned to these zones were now increased to 0g, 0.15g, 0.25g and 0.35g for the respective zones. In 2006 a new code was proposed by the BRRI but the seismic hazard map remained unchanged from the 1990 version [9].

An examination of the seismic hazard maps shows that the map in the 1988 code was largely guided by the isoseismal map of the 1939 earthquake with some modification to account for the effects of a 1906 Ho earthquake [5]. The 1990/ 2006 seismic hazard map is also very similar. It is predominantly influenced by the

1939 earthquake except that some smoothing has taken place to include the whole of the Akwapim fault zone into the zone with the highest peak ground acceleration. Areas along the coast which fell within isoseismals of VII, VIII and IX in the 1939 earthquake have also been included [9].

Other attempts to characterize the seismic hazard of Ghana have also been deterministic in approach [4] [10]. In the most comprehensive approach so far, an earthquake catalogue for Ghana covering the period 1615-2003 was used to produce an epicenter map with superimposed isoseismal maps from the different earthquakes. The result was an epicenter map with intensity isolines. This gave an indication of the maximum intensity expected at each location. Peak ground accelerations were to be estimated from the expected intensities [4].

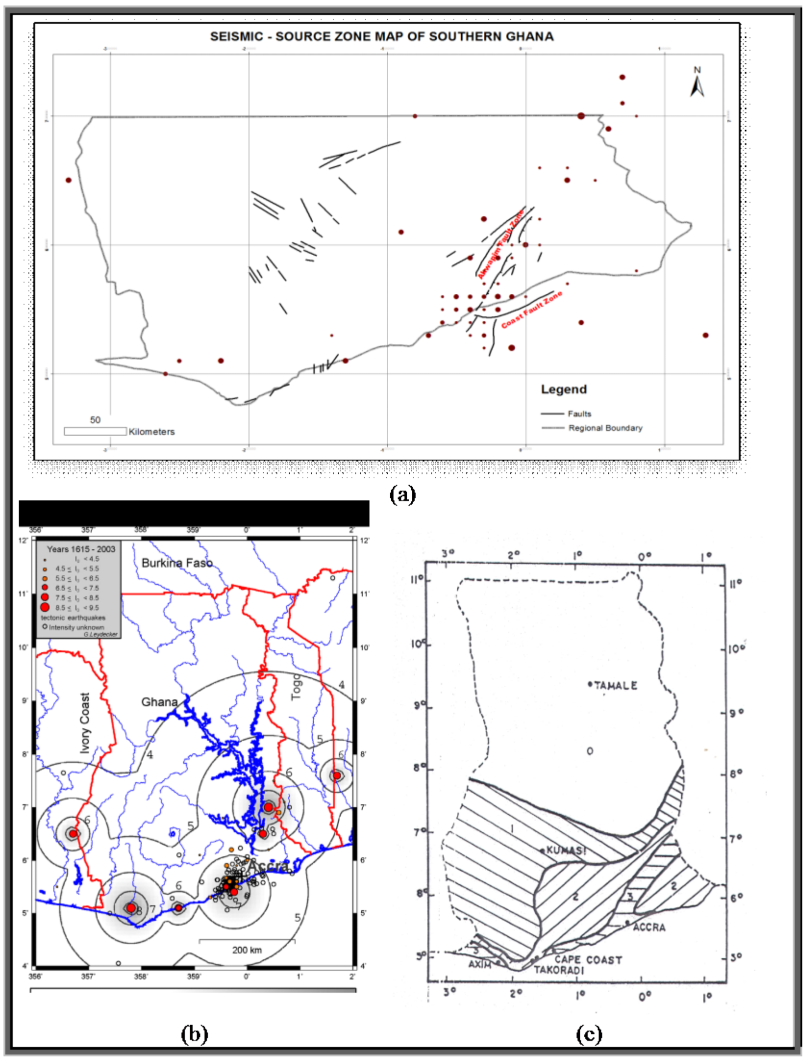

Fig 1 - (a) Seismic Source Zone Map Showing Akwapim Fault Zone and Coastal Boundary Fault -: Digitized from Microseismic Activity Map of Southern Ghana, (b) Epicenter map of Ghana with intensity isolines [4]. (c) Earthquake Risk-Map. Zone 0 is 0g, Zone 1 is 0.15g, Zone 2 is 0.25g and Zone 3 is 0.35g [9].

2.4. Selection of Site for Specific Recommendations

The seismicity map of Ghana shows a concentration of seismic activity at the junction where the Coastal Boundary Fault and the Akwapim Fault Zone meet. This also happens to be where the capital city Accra is located. All the seismic hazard maps produced for Ghana have also placed Accra in the highest zone for peak ground acceleration. Accra was therefore chosen to be the main target for specific recommendations for risk reduction in schools in view of its vulnerable location.

3. Current Practices in the Design and Construction of School Buildings

The overall configurations of school buildings are rectangular, L-shaped, or U-shaped. Primary and Junior High Schools tend to be single storey buildings while those for Senior High Schools tend to be two or three-storey (Fig. 2a). The schools generally have structural bays repeated at classrooms with minor variations at stairwells and toilet rooms.

School buildings are typically poured-in-place concrete-framed buildings with unreinforced masonry infill walls. Masonry infill walls are made from sandcrete blocks (Sandcrete blocks are made from cement and sand, usually river sand and are a common construction material in the former British colonies in West Africa). The sandcrete blocks are constructed in tight contact with the perimeter concrete frame (Fig. 2b). Intermediate floors are poured-in-place reinforced concrete construction but at roof level, the reinforced concrete slab is replaced by un-topped, lightweight metal deck pitched roofs supported by timber trusses that span between perimeter concrete beams (Fig. 2c). The trusses are the only form of out-of-plane bracing for the masonry infill walls as there is no independent concrete diaphragm at the top storey ceiling level. Intermediate floors are generally one-way slabs spanning between beams and girders, which are supported by square or rectangular columns. Exterior walkways are cantilevered and consist of horizontal extensions of the floor beams. (Fig. 2d). Expansion/contraction joints are usually located every three to four structural bays and are approximately 25-50 mm in width.

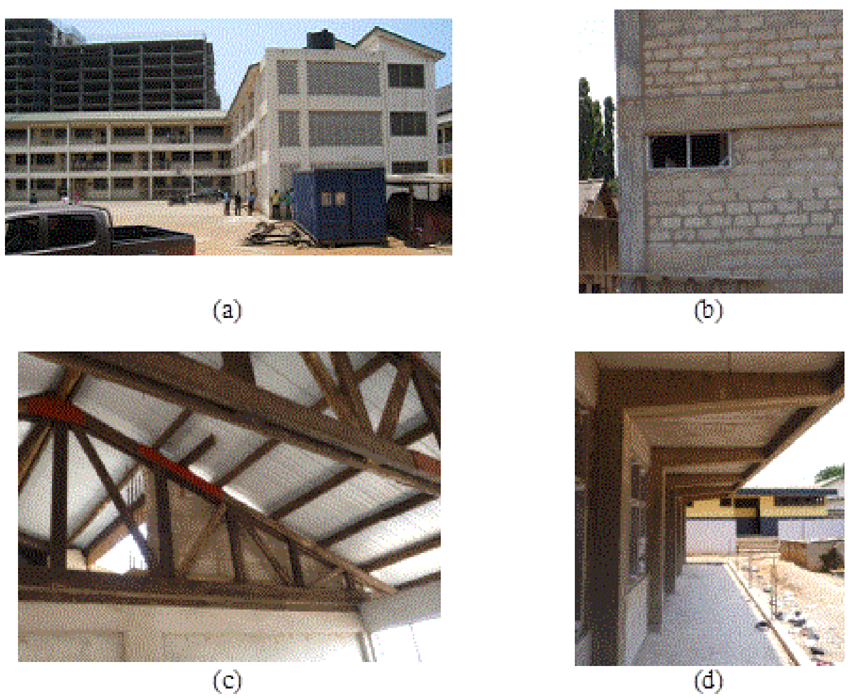

Fig 1. - Typical school building (a) Senior High School block, (b) Sandcrete block wall in tight contact with reinforce concrete frame, (c) Roof trusses, (d) Cantilevered walkway

3.1. Comments on Architectural Aspects

A number of observations were made about the current building design that could lead to unintended consequences and a detrimental effect on buildings. Features such as cantilever framing and discontinuous vertical elements (e.g. walls and columns) should be avoided as damage would often concentrate in these locations. L and U shaped buildings could be broken up into their constituent rectangles by introducing expansion joints at the corners or bends. This would minimize seismic damage at these locations. It was also observed that there was a need to ensure adequate separation between adjacent buildings as pounding between buildings could lead to increased seismic damage to both buildings. A minimum separation of 10 cm was recommended. In addition further evaluation was recommended for egress paths and building contents.

3.2. Comments on Construction of School Buildings

A number of findings about the current practices in the construction of the school buildings gave cause for concern. Sandcrete blocks were produced using forming/compaction equipment and they were batched using simple volumetric ratios of the constitutive materials. Concrete was also typically site-mixed involving volumetric portioning of materials. The concern was that the volumetric proportioning of materials for producing sandcrete blocks and concrete would result in variability in strength.

Whilst it is common design practice to assume that the masonry infill walls are nonstructural elements, it has been found that building masonry walls in tight contact with perimeter concrete frames adversely affects seismic performance.

Another issue of concern was raised by local contractors and practitioners. They complained that reinforcing steel suppliers sometimes provide bars of smaller diameter than specified. This can result in construction that does not conform to the design drawings and can result in a weakened structure. A study of locally manufactured bars in Ghana also found that they lacked sufficient ductility [12].

3.3. An Evaluation of Seismic Performance of Typical New School Buildings

In order to analyze the seismic performance of a typical new school building, a Tier 1 evaluation for Life Safety performance, per the American Society of Civil Engineers Standard for the Seismic Evaluation of Existing Building (ASCE 31-03) was conducted. This evaluation revealed a number of potential deficiencies:

1. The shear stresses in moment frame columns exceed safe limits. This can lead to excessive lateral deformations, degradation of concrete within the columns, and possible loss of gravity capacity.
2. Expansion/contraction joints between adjacent buildings and between stairs and the building are not sized to function as true seismic separation joints, so some pounding damage is expected, which may lead to loss of egress paths.
3. There is inadequate separation between infill walls and structural columns. The interaction between the structural frame and the non-structural masonry wall is not considered in the design of the frames. This leads to a short or captive column condition in which the lateral deformation of a storey is concentrated over the reduced free height of the concrete column. In past earthquakes, this condition has led to column shear failure and partial structural collapse.
4. The reinforcing detailing does not meet the design requirements for a ductile structure.

3.4. Comments on Building Codes and Level of Peak Ground Acceleration Used in Design

During their visit to Ghana, the Housner Fellows found that engineers were using a number of different codes in design. The 2006 Code for Seismic Design of Reinforced Concrete Structures is the most current local design standard. It follows a similar code published by the BRRI in 1990 and an earlier code published in 1988. None of the BRRI codes were legally adopted or enforced and this has allowed for a wide variability in design practice. Whilst some engineers referenced the BRRI Codes, others referenced available standards such as the Eurocode, ACI 318, and ASCE 7 in their design practice.

Even amongst those that referenced the BRRI codes, the values of peak ground accelerations used in design varied. Some used values given in the BRRI 1988 code map whilst others used BRRI 1990/2006 values. There were yet others who believed that values that lay between values given in the two codes were more appropriate. It was clear that engineers needed guidance on the level of peak ground acceleration to be employed in the design of buildings. This project endorsed the peak ground acceleration of 0.35g for Accra as recommended by the 2006 BRRI Code [9].

4. Improving the Earthquake Safety of New School Buildings

The study of current practices suggests that if school buildings continue to be designed and constructed as they have been their seismic performance will not be at the desired level. School buildings in Ghana have traditionally been designed for a 100-year lifespan, but the majority of them have been built with little or no provision for resisting seismic forces and they are unlikely to be capable of resisting the level of earthquake action that is probable within this design period. It was found that most of the problems observed could be addressed through appropriate clauses in a legally binding building code.

4.1. Proposed Amendments to Building Code

The following revisions to the 2006 Code were proposed to provide the desired seismic performance level for ensuing designs.

1. Provide a clear definition of the building code's intent with respect to seismic performance objective (e.g., "Safe and Usable during Repair").
2. Provide table showing correspondence of "Class" assignment for buildings with "Ductility Level" assignments. Currently the code states that "Class 1 structures to be built in high seismicity areas shall be preferably designed to ductility level III." We recommend that the word "preferably" be removed; use mandatory language.
3. Revise importance factor definitions for critical building structures: schools, hospitals, and religious centers. Importance factors are typically used to provide increasing levels of seismic performance for important buildings. Currently the 2006 Code classifies school building as "Class 1" critical structures. In order to achieve a "Safe and Usable during Repair" performance level, we recommend that the code be updated to state that Class 1 structures should be horizontally and vertically regular. Similarly, this recommendation could be extended to prohibit vertical setbacks in Class 1 buildings.
4. Update characterization of seismic hazards using probabilistic seismic hazard analysis methods and also include both short- and long-period seismic design values.
5. Add requirements for designing lateral systems for bi-directional loading (e.g., 100% + 30% orthogonal loading combination).
6. Provide lateral system-specific design parameters that consider the displacement ductility capacity of each system, especially when considering local construction practices and material and quality control limitations. The building code currently provides this through the use of K factors. The K-factors for structures having poor detailing, low concrete strength, and lower ductility should be assigned conservative values of K-factor.
7. Develop material-specific design and detailing requirements that align seismic hazard, lateral system, and occupancy considerations to achieve the desired seismic performance.
8. Add quality control and inspection language to ensure that the proper materials and construction techniques are applied throughout the construction process.
9. Include provisions for adopting and updating future code requirements through a consensus-based process that equally considers input from engineers, researchers, governmental officials, contractors, and suppliers. This process should be considered in the development of a legally adopted code.

4.2. Procedure for Implementing Building Code Amendments

The development and implementation of a building code differs significantly between developing and developed countries. Generally, codes are developed through the joint efforts of industry, research institutions (universities), professional bodies, and regulatory bodies. However, developing countries face numerous challenges in this regard for reasons such as lack of legal framework, stakeholder coordination challenges, financial constraints, and general lack of awareness.

The following processes were recommended for Ghana from the experience of Pakistan which is also a developing country. The process was precipitated by a damaging Magnitude 7.6 earthquake in 2005 which claimed more than 80,000 lives and left more than 4 million people homeless [14].

1. Sensitize people and start a dialogue in Ghana related to seismic issues
2. Form a consortium of stakeholders, including but not limited to AESL, GhIE, GhES, NADMO, universities, professional licensing bodies, contractor association, school administrators, Ministry of Education, Law Ministry, local and international NGOs, and EERI. The consortium can be helpful in sensitizing people and starting background work for initiating national code adoption.
3. Review existing laws related to regulation of the engineering profession in Ghana. This could reveal a way forward that would build common ground among stakeholders.
4. Seek funding from local and international sources to support the first legal code adoption process. This should involve all stakeholders including experts from other countries.
5. Set a timetable for completion. A reasonable expectation would be that in two to three years a code would be adopted and enforceable.
6. Plan to revise the code on a regular basis to incorporate new scientific information. Ideally, this would be done approximately every five years.

5. Evaluating Existing School Buildings

A comprehensive program on school seismic safety should include reducing the risk to existing school buildings. This is however an expensive and long-term process with many economic, political and social challenges. The project therefore set out to outline a potential process for evaluating and retrofitting existing school buildings, recognizing that such an effort would require many years to implement.

The fact that most schools follow a standard design in Ghana provides a unique opportunity to assess broad segments of school buildings uniformly and to develop uniform plans for detailed evaluation and retrofit.

The following steps outline one possible process for addressing seismic safety of existing school buildings based on GFDRR [15].

1. Identify key partners who can contribute to a safer schools initiative, and form a coordinating group to lead the initiative.
2. Determine risk in order to determine those existing schools in need of urgent intervention
3. Define performance objectives for the mitigation of damage, loss and disruption to important school assets and services.
4. Adopt building codes and retrofit guides.
5. Assess school sites for site-specific hazard characteristics.
6. Assess the vulnerability of existing school buildings including the structural and non-structural components
7. Conduct detailed evaluations where required
8. Prepare a retrofitting plan that satisfies the performance objectives and school design criteria.
9. Assure quality of construction and retrofit works to achieve higher safety standards for existing schools

6. Ensuring Earthquake Preparedness in Schools

A key element of any program on school seismic safety is to educate school children on what to do before, during, and immediately after an earthquake. Whilst school children may be the target audience for an earthquake safety curriculum, the impact of teaching children often goes much further as children bring the lessons back to their parents and the larger community. In addition, when they become parents with children of their own, they will understand the vulnerabilities and act to protect the next generation. While some school children in Ghana regularly perform fire drills, earthquake drills are not generally performed. To this end, the Housner Fellows worked with ShakeOut, a global earthquake drill and curriculum, to develop a Ghana specific webpage and performed a ShakeOut drill with students during their visit. In addition to teaching children to "drop, cover and hold on", ShakeOut educates on steps to take immediately following an event. For schools, engaging annually in the ShakeOut drill provides a great opportunity to review their earthquake response plan, make any updates, and consider simple mitigation measures such as securing falling hazards within the school.

7. Engaging Stakeholders to Promote School Seismic Safety

Whilst in Ghana, the Fellows met with several stakeholder groups to sensitize them about earthquake safety for schools and to get them to play a role in promoting the issue. Those met included the following:

1. The Architectural and Engineering Services Ltd.,(AESL), consulting engineers and architects who design Ghana's public schools.
2. The Ministry of Education, the entity that commissions public schools.
3. The National Disaster Management Organization, (NADMO), the group responsible for disaster preparedness and response in Ghana.
4. The Ghana Institution of Engineers (GhIE), the licensing body and professional organization for practicing engineers.
5. The Ghana Earthquake Society (GhES), the professional organization for practicing engineers, academia, and seismologists, similar to EERI.
6. The Association of Building and Civil Engineering Contractors in Ghana, the professional organization representing Ghanaian contractors.

For each stakeholder, their main goal whom their targets will be, their main message to the target organizations, the key issues, methods and tools they can employ and ways of evaluating success. The main outcomes from the discussions with the various groups are summarized in Table 1.

8. Conclusions

Making schools earthquake resistant is most cost-effective during design, and more difficult and expensive for schools that are already built, but Ghana has an unparalleled opportunity with its new school construction to save lives and build community resilience. As a first step, this project has provided pragmatic guidance to enable Ghanaian Engineers and Architects to improve the earthquake resistance of new schools. It has also helped to increase awareness of the need for earthquake safety of schools as a result of interactions with various stakeholders during the course of the project and the publicity received by the Fellows during their visit to Ghana. Furthermore, it has produced an outline of processes that various stakeholders may undertake to improve the seismic safety of schools in Ghana and the issues they must address. Key amongst the issues to be addressed are:

1. The formal adoption of a policy on the performance requirements of schools in Ghana (i.e. "Safe and usable during repairs" performance)

2. The development of guidelines for the design of new school facilities in Ghana and the adoption of these guidelines by the Ministry of Education.

3. Revision of the seismic code to include amongst other things an updated characterization of the seismic hazard in Ghana produced from a robust probabilistic seismic hazard assessment.

4. Development and adoption of a legally binding building code.

5. Adoption of an Earthquake Safety Day and other measures to ensure earthquake safety awareness in schools.

Table 1. - Summary Table on Outcome of Stakeholder Consultations

STAKEHOLDER	METHODS & TOOLS
Ministry of Education (MOE)	Formally adopt a policy on performance requirements for all schools, ("Safe and Usable during Repairs" performance) and make appropriate budgetary provisions for construction of seismically safe schools. Commission the AESL to produce "Guidelines for the design of all new school facilities in Ghana." Use peer review to check designs. Institute a program to inspect and classify existing schools and prioritize retrofitting of unsafe schools. Work with NADMO and school administrators to institute an earthquake safety day in schools. Conduct unannounced drills to verify state of preparedness.
Architectural & Engineering Services Ltd. (AESL)	Work with GhES to develop guidelines for design of new school facilities and encourage the MOE to adopt the guidelines for all schools. Provide training on guidelines to staff and implement guidelines. Adopt Peer Review System within AESL to check designs and provide inspection during construction.
Ghana Earthquake Society (GhES)	Use the Housner Fellows Report as tool to engage all stakeholders. Agree with GhIE a procedure for development and adoption of a legally binding building code and work to ensure its adoption. Obtain the Support of the Ghana Geological Survey Department and GhIE for the development of a new seismic hazard map. Assist AESL to prepare guidelines for the design and retrofitting of schools. Advocate for teaching of seismic design principles to architects & engineers. Work with the MOE and NADMO to institute Earthquake Safety Day for Schools in Ghana
National Disaster Management Organization (NADMO)	Work with MOE to institute an Earthquake Safety Day for schools. For this, tap into resources provided by Shakeout. Also, coordinate regular earthquake "drop, cover, hold on" drills. Use Earthquake Safety Day to increase awareness of earthquake hazards.
Ghana Institution of Engineers (GhIE), Engineering Council, Ghana & Ghana Consulting Engineers Association **Ghana Institute of Architects & Architects Registration Council**	Agree with GhES a procedure for adoption of a legally binding modern seismic code and explore avenues for funding. Support GhES in efforts to perform Probabilistic Seismic Hazard Assessment (PSHA) for Ghana. Emphasize need for new Seismic Hazard Assessment and legally binding building code in meetings with legislators and government officials. Work with GhES to organize training in seismic design. Encourage universities to include modern seismic design in curriculum.
Association of Building and Civil Engineering Contractors in Ghana	Work with GhES and GhIE to hold training workshops for members to train them in principles of modern earthquake-resistant construction.

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