SEISMIC RETROFITTING OF PUBLIC SCHOOL IN MARKAZI PROVINCE

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Keywords: Schools, Earthquake, Iran, Disaster, Seismic Retrofit

ABSTRACT

The essential priority of protecting children who attend schools that are vulnerable to collapse during an earthquake is irrefutable. The structural integrity of public schools in Markazi Province, IRAN is a source of deep concern due to their outdated design, deteriorated status and apparent lack of compliance with seismic design regulations. The purpose of this article is to advocate the seismic retrofitting of school buildings and to demonstrate the financial gain of such retrofitting procedures when compared with the cost of repair or replace ment. In this paper, the authors offer practical information supported by numerical data, regarding the urgent priority of retrofitting school buildings and enhancing their functional capacity to withstand future destructive earthquakes. The aim is to alert school administrators, public leaders, government officials and international agencies regarding the seismic vulnerability of public school buildings and their subsequent effects on the safety of children in Markazi Province, IRAN. In addition, the authors demonstrate the economic advantages of seismic retrofitting in protecting children and their schools and calls for government intervention to assess and retrofit public school buildings to reduce their vulnerability to collapse during future earthquakes.

The vast majority of public schools in Markazi Province, IRAN is located in earthquake-prone regions, and they have insufficient resistance capabilities to remain structurally sound during an earthquake. Thus, these schools are highly vulnerable to existing earthquake hazards and are susceptible to collapse and failure in the event of a strong earthquake, which could lead to mass casualties of students and teachers and heavy damage to school buildings. School earthquake safety could be achieved by means of a collective effort geared towards structural retrofitting, capacity building, education and awareness. One way to mitigate earthquake damage is to reduce the fundamental risk factors by strengthening the structures. While the focus of this paper is on the urgent need for seismic retrofitting of school buildings in Markazi Province, IRAN, promoting school earthquake safety also has the potential to contribute to safer communities. Markazi Province, IRAN has a confirmed seismic risk, and thus, government officials should acknowledge their moral obligation to protect the children who are obliged to attend schools that are highly vulnerable to collapse during an earthquake. Public schools in Markazi Province, IRAN should be assessed and evaluated to ensure their structural integrity in terms of seismic resistance capability, and they should be retrofitted to ensure structural survivability, and thus, children's safety. The cost of retrofitting existing school buildings will not be at the expense of the educational opportunities of future children, nor will it hinder the establishment of new school facilities when needed. Therefore, the Iran Ministry of Education should either develop a subsidy programme or seek potential donors for the seismic retrofitting of school buildings and should publish technical guides to help engineers determine appropriate retrofitting strategies, both technically and economically.

INTRODUCTION

There is no shortage of public schools in MARKAZI province as they are adequately dispersed throughout the country's populated regions. However, most of the existing school buildings are ageing, deteriorating and do not meet the safety standards of public buildings [Berberian, M., 1976] .The lack of regular maintenance and the buildings' outdated designs and poor construction methods have contributed cumulatively to this grave situation. In addition, school buildings have not been designed to be earthquake resistant. This deficiency will be catastrophic in the event of a strong earthquake as it increases the children's vulnerability to Corresponding author. Such a hazard. Prioritizing seismic retrofitting strategies for public school buildings at a minimum cost to the institutions is the key to preventing the sudden collapse of these facilities and reducing the number of tragic fatalities among children and teachers. Therefore, public schools in MARKAZI province must be upgraded to enhance their seismic resistant capacity and ensure the safety of the children and survivability of the buildings. Earthquakes have serious consequences on educational services, not only because they induce structural collapse and massive loss of lives of teachers, staff and students, but also due to the sudden interruption of the educational process and psychological disruption of students (Berberian M and Ramazi HR 1987). Schools are places where a vulnerable part of society is located; therefore, it is essential that children are protected as much as possible from the effects of earthquakes (Cornell CA, 1968).

The destruction of vulnerable school buildings by earthquakes has been documented in many places around. All rights reserved the world. These events reduce the functional capacity of the educational system, thereby hindering students' academic progress. The 1995 Kobe earthquake caused extensive and varied damage to approximately 4500 educational facilities. Fortunately, no fatalities resulted from this damage to schools because the quake struck the area early in the morning (Green A and Hall J, 1997) .In the 1999 Chi–Chi earthquake, a total of 700 schools were destroyed in Taiwan. The 2001 Gujarat earthquake in India caused damage to more than 11,600 schools (Mirzaei N, 1997). More than 10,000 school buildings collapsed as a result of the 2005 Pakistan earthquake (Nabavi M, 1976) ,leaving surviving children without educational facilities. After hurricane Katrina, hundreds of students in New Orleans were turned away from public schools due to the lack of space and shortage of teachers (Ramazi HR, 1990). As many as 1150 schools in Indonesia were damaged or destroyed in the 2004 earthquake (Ramazi HR, 1995).During the Sichuan earthquake of May 2008, Approximately 10,000 students were crushed in the more than 7000 school classrooms that collapsed (Reiter L, 1990) . In addition, approximately 38,000 students died in the Haiti earthquake, which also killed 1300 teachers and other personnel Ben-Menahem A and Aboodi E1981). The Ministry of Education offices were destroyed, along with 4000 schools—close to 80 percent of the educational sector in the Port-au-Prince area. In 2006–2007, the United Nations International Strategy for Disaster Reduction (UNISDR) carried out a global campaign titled Disaster Risk Reduction Begins at School, with support and contributions from all UNISDR system partners. This programe resulted in a significant mobilisation of efforts to promote school safety and the integration of disaster risk reduction into school curricula, as well as the recognition of nonformal education activities as a crucial contribution to awareness raising, knowledge building, and skill development for disaster risk reduction(Bhuwanee T . Welcome to Unesco Haiti. UNESCO; 2010) .According to the 1390 census, the population of 1,413,959 people. The province has an area of 29,530 square kilometers. According to the latest divisions, Central Province has 12 city, 23 districts, 32 cities, and in 1394 the village. Central Province 261,371 students in 2648 schools. MARKAZI province has been successful in making education compulsory for its citizens up to middle school; however, no special attention has been paid to the seismic safety of the school buildings. Consequently, it is highly possible that thousands of children will face death or injury at the occurrence of an earthquake while they are attending school. Recent research released by World Vision revealed that despite being at risk of both manmade and earthquake hazards, MARKAZI province has few disaster risk reduction measures in place to minimize the human and economic costs of such disasters. The lack of awareness about disasters and preparation for them is one of the main reasons for the poor resilience of these communities after disasters. For example, information regarding disasters is not shared with children in schools (CERD 2014).The scope of this article is to advocate the safety of poor and innocent MARKAZI province children who are obliged to attend ageing, ill-maintained and seismically vulnerable public schools. The intention is to motivate school administrators and teachers to exert enough pressure on government officials to prioritize the structural safety of the existing schools to prevent future tragedies. Although private school buildings have not been seismically designed, they are in excellent conditions and have better resistance to moderate earthquakes, due to their high level of design and construction standards, their regular maintenance and the high revenue generated by the high student enrolment numbers the number of students enroled in private schools is almost two third of the total student population [Coburn AW , JICA,1992,2004.] .

EARTHQUAKE HAZARD IN MARKAZI PROVINCE

Seismic hazard assessment is carried out for 48.5 - 51 ˚E and 33 – 36 N ˚ including MARKAZI province (central province). Five potential seismic sources have been identified by analyzing geology, seismology and geophysics data in the studying area. At last, peak ground 10 iso-acceleration maps for return period have been displayed by probability method. Seismic zone map of MARKAZI province shows peak horizontal acceleration for 10% probability in 10 years is 0.2g. MARKAZI province can be divided into different zone with relative risk. The quietest zone is in west. There are regions in north with high relative risk around Indes, kushk Nosrat, Khoshk rud Fault. There is the same situation for a small zone in west north which is in east north of Dorud Fault.

FAULTING, TECTONIC AND SEISMOTECTONIC PROVINCE-WIDE

Central province to the development of the Alborz, but some of the major faults in Alborz can also shake the northern parts of the province. central province in the Centrally located of geologic country. The process of State structures in the region is influenced by neighboring species of large faults that trend in the North of the province, including the fault "Coshk Nosrat", is in the process of the fundamental structures of the Alborz mountains. The process of the main faults in the Center and East of the province, including the fault of "the Tafresh, Talkh AB, MARKAZI and Tabarte faults" of fundamental fault of Zagros is almost parallel with the process of North South has a process with a tendency toward South-North and The seismicity has been remarkable. New tectonic MARKAZI province is strongly influenced by the performance of the above faults. The "Aindes" fault in the North East of the province, including the fault of another is North of Salafchegan criterion extends of Saveh and Saveh southwest border has created. In addition to the above, another group of main faults there are many of them and process more than the angle of approximately 80-60 degrees with the main group, and this is almost North of West-South West.

WHY SHOULD SCHOOLS BE SEISMICALLY RETROFITTED?

It is worth mentioning that 2500 children worldwide die each year in school collapses[Petal Marla ,2008] . The earthquakes that have occurred worldwide since the year 2000 have claimed lives of more than 28,000 children and teachers due to unsafe school buildings . The retrofitting of existing schools and the implementation of seismic designs in newly constructed ones can promote the value of safe buildings in the surrounding community and thus encourage the community to develop further earthquake disaster mitigation measures. When their structural safety is ensured, schools can continue to function during the period following an earthquake disaster. They can also support relief efforts and provide shelter to earthquake victims. Schools in MARKAZI province both the buildings themselves as well as their occupants—face extreme risk from earthquakes due to their structural vulnerability, high occupancy and high seismic hazard. The seismic risk of such facilities is high because the earthquake hazard is high and mitigation is low. All schools in MARKAZI province have architectural irregularities and have been constructed using a rigid reinforced concrete and non-ductile frame system. This design has produced heavy structures with poor ductility behaviour and brittle connexions existing among the main structural components, which can lead to their sudden structural collapse during earthquakes.

Geologists have confirmed that MARKAZI province is anticipating a destructive earthquake that can strike at any time in the coming years (Degg M, Homan, Moehle J,2005,2000) .Given the existing quality of construction and deficiencies in seismic resistant capabilities, it is expected that at most 20 percent of the existing school buildings will be able to withstand and exhibit resistance to structural collapse resulting from the expected 7.0 moment magnitude earthquake, while the remaining ones will facepartial to total collapse due to their ineffective seismic resistance capacities, poor construction methods, ageing structures and lack of maintenance. Thus, out of the existing 2648 public schools, only 530 have a chance of successfully withstanding the earthquake. Rural public schools in MARKAZI province typically have a student enrolment of 50–250 students, while their urban counterparts have approximately 150–450. Thus, an average of 150 and 300 students are enroled in rural and urban public schools, respectively. According to (Grant DN, Bommer JJ,2007) , 80 percent of the MARKAZI province public schools are concentrated in urban areas, while the remaining ones are scattered around the countryside. Using the lowest figures in the above enrolment ranges, a minimum average of 194 students per school can be used in the estimation of student casualties due to a strong earthquake. A brutal earthquake could kill between tens and hundreds of students per school, due to the following facts:

MARKAZI province public schools have been traditionally constructed using a rigid reinforced concrete frame with no lateral resisting system. Thus, the collapse of such heavy structures will have detrimental effects on the survival rate of their occupants .The MARKAZI province emergency response system has been consistently ineffective and unreliable in previous crisis response situations. Thus, inadequate search and rescue teams will not be ready to undertake immediate rescue missions in the face of such an overwhelming incident, with thousands of collapsed buildings and trapped and injured victims needing immediate life-saving assistance .

THE STRUCTURAL STATUS OF PUBLIC SCHOOLS

Historical records have shown that earthquakes in MARKAZI province are low-probability events with severe consequences although they may only occur once in the lifetime of a school, they can have devastating consequences. The effects of a moderate earthquake (with a magnitude of around 6 on the moment scale) can cause severe damage to building structures, which might lead to serious injuries among students and staff. A major earthquake (with a magnitude of around 7 on the moment scale) can lead to structural collapse and substantial loss of life (Nakano Y,2004) . Schools in MARKAZI province are usually one to three-storey, reinforced-concrete buildings with ordinary rigid reinforced frames and concrete slabs. Most of the school buildings are old, poorly constructed and poorly maintained. They are narrow and rectangular or L-, Tor U-shaped, and these plan types may be especially vulnerable to seismic activity. Some of the existing schools were originally designed and used as residential apartment buildings and then modified and converted into schools, while other school buildings were expanded vertically by adding a few residential storeys. The modifications were made without taking into consideration the basic safety requirements and seismic regulations in place to ensure the safety of children during the moderate ground shaking when a sudden earthquake occurs. Because they are rented by the Ministry of Education at high rates directly from private MARKAZI province owners, the rental agreements oblige schools' owners to take full responsibility for the maintenance and safety of the school buildings. However, due to a lack of government enforcement, the owners ignore the regular maintenance and the fulfilment of agreements. Therefore, if a long-term seismic retrofitting plan is to be implemented, the owners of the public school buildings will not be willing to take part in sharing the financial burden with the government, and the government will be discouraged from taking any initiative in this regard. A field trip to public schools was conducted in Khomein, which is the third highest populated city in MARKAZI province with the intended mission of surveying their structural safety conditions. 10 of the 20 schools were surveyed,6 buildings were considered to be in acceptable condition, five needed to be maintained but were structurally sound, and the remaining four were identified as deteriorated and required strengthening due to obvious stressed and cracked structural components and sections. Descriptions of the two deteriorated buildings, which are one to three storeys in height and over 25 years old, are provided in Table 1. It is worth noting that none of the 10 school buildings surveyed met the minimum architectural and structural standards for resisting earthquakes.

WHY SHOULD THE SEISMIC SAFETY OF SCHOOLS BE PRIORITIZED?

Most MARKAZI province educators and educational administrators are unaware of the existing seismic risk and the high risk of sudden school building collapse during future earthquakes [Reiter, L., 1990]. These educators and administrators have a tendency to take lightly any issue that does not lead to educational improvement and quick outcomes. It is for this reason that seismic safety of school buildings has never been prioritized. While the assertion of children's rights is elegantly spoken, children's right to education should never be at the expense of their safety. Children's lives should never be risked for the sake of education. It is the responsibility of government authorities and education administrators to provide children with educational opportunities in a safe, protective environment. The right to safety and survival and the right to educational continuity must be equally ensured as elements of recognized human rights and both must be taken seriously(INEE,2001) . School administrators in MARKAZI province prioritize issues related to curriculum reform, hiring more teachers, securing funds for educational activities, purchasing more computers and software and rushing to expand school complexes to accommodate more students but ignore unprotected innocent children and vulnerable, unsafe buildings. Moreover, because of their influential and symbolic position in the community, the protection of schools is crucial during and in the aftermath of disasters(Ramazi, H. R., 1995). In addition to being the source of education for children, schools often play a significant role in shaping and reshaping children's attitudes and misconceptions about various aspects of life. The evidence has demonstrated that cultural misconceptions and incorrect beliefs and attitudes can lead to inadequate behaviour in preparing for and responding to sudden disasters . Schools also host social, political and religious activities, connect various community groups through activity programmes, and can serve as awareness and vaccination centres in epidemic situations. Moreover, a reliable, safe school building can be used as a temporary shelter in the aftermath of an earthquake, can promote a culture of safety and can contribute to community resilience through disaster awareness activities. Such a role in pre-disaster mitigation and post-disaster rehabilitation can have a positive impact on a community .Thus, schools play a key role in maintaining social networks, promoting hygiene and public health and contributing to sustainable living. While estimating the financial value of these social gains is difficult, it is evident that these functions add value to school buildings[Petal Marla,2008] . Therefore, the school is the most critical social institution and must be preserved, protected and maintained to advance our outlook on life and ensure the progressive thinking of future generations.

THEORETICAL ESTIMATES OF SEISMIC HAZARD:

Estimation of earthquake risk on acquired land movement parameters in a construction site may be that With potential seismic activity of the fountain in a specified time period will be This is done in the following ways: First, the experimental method - is significant that this method is the simplest way to assess the seismic hazard and Based on the statistics of earthquakes occurred in the study area.

The second method is no method to bring on the earthquake risk using this method, it is necessary that the following steps be taken. First, determine the potential of earthquake fountains, then determine the maximum that can be of any great spurt expected, and The next step is to determine the relationship and suitable for the expected area and finally the determination of the risk or the maximum acceleration of the Earth. In this way the movement of land obtained for the construction of the earthquake are not only characterized by a fountain with the distance of the structure can be expressed. Regardless of an earthquake occurrence probability with different characteristics exist. The reason for the main site, the earthquake hazard assessment, this method is not reliable And the third method, the method of probabilistic estimation methods which are contrary to the absolute risk of earthquake potential, of all the great ways may result from different distances of the structure have been found, taking into account the probable percentages of expression. This method is based on determination of the Earth movement on the covers with a specified probability, it is possible for the construction. Risk estimation steps possible method to earthquake is done in four steps. The first step is to determine the potential of the earthquake is a fountain. The second stage of the relationship between the volume of distribution and a great comeback, the manifest shall be the mean rate of occurrences. The third stage were used to weaken the relationship and finally in the fourth phase of the risk curve for construction will be calculated. Determination of seismic sources and attenuation relationship is the same exact way. Probabilistic method in the effect of all different sizes and earthquakes in various places of different events with probability of different events may occur, are collected on a curve, which increased the likelihood of fighting various levels of the Earth movement (for example, maximum acceleration) at a certain time during the construction period of the show.

POTENTIAL SOURCES EARTHQUAKE:

The first step in seismic risk analysis to determine the source or sources of the earthquake Tectonic earthquake seismic source or sources of the manifestation of tectonic forces in the region. Detection and identification of seismic sources and tectonics, seismic hazard analysis often constitute the bulk of which require knowledge of the geological, seismic and tectonic regional and local knowledge.

COST OF SCHOOL RECONSTRUCTION AND REPLACEMENT AFTER AN EARTHQUAKE

Even during a moderate earthquake, an existing school building that has not been seismically designed or subjected to seismic retrofitting will perform poorly. A typical school building in MARKAZI province ranges in area from 200 to 2000 m2 depending on its location, functionality and the population of the community in which it is situated. Assuming that a typical school has an average area of 350 m2, based on the author's expertise in the MARKAZI province engineering and construction industries, an estimated school construction cost can range from 8000,000 to 9000,000 (Rial) per square meter. Thus, the average construction cost of a new school building with an area of 350 m2 is approximately 2,975,000,000 Rial. An earthquake with a moment magnitude of 7.0 can lead to partial or total collapse of 70 percent of the existing MARKAZI province school buildings of which 30 percent will be beyond repair, totalling 780 schools. The replacement cost of these collapsed, unrepairable schools is 780 * 2,975,000,000 = 2,320,500(thosands Rials).The remaining 900 schools will require minor to major rehabilitation at an average repair cost of 25 percent of the replacement cost, totalling 900*2,975,000,000= 2,677,500(thoasand Rials), the repair and replacement of 1680 schools affected by a devastating earthquake would require a budget of 2,320,500+2,677,500= 4,998,000 (thoasand Rial). For every delayed year of an earthquake occurrence, 3 percent must be added to this figure. emphasized as a temporary alternative, and a low-cost partial strengthening procedure should be implemented. However, the perseverance of community leaders and the continuing pressure on government authorities to implement seismic retrofitting for public school buildings must remain essential in order to save MARKAZI province's children from the destruction of earthquakes. As a matter of fact, on December 29, 2013 Saudi Arabia pledged $3 billion to the MARKAZI province Ministry of Defence to strengthen the capabilities of the MARKAZI province military and to fight terrorism . A future initiative by the Ministry of Education for the seismic retrofitting of public school buildings might gain partial financial support from the government and open the door for more generous support from the international community. The fact is that people in MARKAZI province are more concerned about civil war nowadays than about future earthquakes. Indeed, the terrible memory of the sectarian civil war of 1975 that took the lives of over 120,000 MARKAZI province is still on the minds of most MARKAZI province people who have never seen or witnessed a destructive earthquake in their lifetime. Thus, for most MARKAZI province people, investing in the national military forces to reduce the risk of future civil war is much more rewarding than protection of public buildings against a possible earthquake that may not occur during their lifetime.

CONCLUSIONS

The vast majority of public schools in MARKAZI province is located in earthquake-prone regions, and they have insufficient resistance capabilities to remain structurally sound during an earthquake. Thus, these schools are highly vulnerable to existing earthquake hazards and are susceptible to collapse and failure in the event of a strong earthquake, which could lead to mass casualties of students and teachers and heavy damage to school buildings. School earthquake safety could be achieved by means of a collective effort geared towards structural retrofitting, capacity building, education and awareness. One way to mitigate earthquake damage is to reduce the fundamental risk factors by strengthening the structures. While the focus of this paper is on the urgent need for seismic retrofitting of school buildings in MARKAZI province, promoting school earthquake safety also has the potential to contribute to safer communities. MARKAZI province has a confirmed seismic risk, and thus, government officials should acknowledge their moral obligation to protect the children who are obliged to attend schools that are highly vulnerable to collapse during an earthquake. Public schools in MARKAZI province should be assessed and evaluated to ensure their structural integrity in terms of seismic resistance capability, and they should be retrofitted to ensure structural survivability, and thus, children's safety. The cost of retrofitting existing school buildings will not be at the expense of the educational opportunities of future children, nor will it hinder the establishment of new school facilities when needed. Therefore, the MARKAZI province Ministry of Education should either develop a subsidy programme or seek potential donors for the seismic retrofitting of school buildings and should publish technical guides to help engineers determine appropriate retrofitting strategies, both technically and economically.

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