Available online at www.ijapas.org

IJAPAS International Journal of Applied Arts Studies

International Journal of Applied Arts Studies

IJAPAS 4(1) (2019) 33–40

The Study of Effective Factors on the Reduction of Earthquake Damages: the Mission of Architects

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Received 07 July 2019; revised 20 August 2019; accepted 27 August 2019

Abstract

As one of the most significant geotechnical hazards, earthquake often threatens Iran's plateau areas. In Iran, the earthquake risk has increased, due to the intensification of the expansion of cities and the concentration of population and working capital. Iran is one of the five seismic countries in the world, due to the Alpin-Himalayan seismic belt. According to the experts, on average, an earthquake with the magnitude of 6 Richter scale occurs each year and a 7 Richter earthquake, every 10 years. In addition, historical surveys also indicate that vast areas of Iran have suffered financial and life losses due to this natural disaster. Therefore, we have to accept the existence of earthquakes, and we need to use the best solutions to reduce losses. In this research, which was done by the library method, initially, we suggest the factors that make it possible to see the increase of earthquake damages and then, by investigating the factors affecting the reduction of earthquake damages and especially the role of architects in this regard, we present the results at the end.

Keywords: Earthquake; Damage; Structure; Architects

1. Introduction

Iran's architecture, similar to other Iranians' cultural manifestations, has had incomparable continuity; it is the result of our ancestors' art and artistic creativity and their inspirations from the traditions and achievements of other nations and in fact, it is the credentials of Iranian people (Seifi, 2010).

According to the earthquake experts, Iran is one of the countries of the world that is prone to earthquakes. Based on the official statistics, six percent of the country's casualties were caused by

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an earthquake in the last 25 years. It can be seen that earthquake occurrence is always possible in different provinces of the country. Accordingly, it is predicted that there are two major earthquakes in Iran, each year (Mahdavi, 2005).

By a glance at the process of occurrence of earthquakes in Iran, it can be concluded that earthquake occurrence is likely in different provinces. Therefore, we must be aware that what makes the earthquake a disaster is the lack of human awareness and the inability to face and deal with this phenomenon; hence, we must think about developing an infrastructure program to reduce the risk and damages caused by an earthquake (Amini et al., 2011). Unfortunately, the evaluation of the causes of the destruction of buildings against earthquakes shows that this issue is not taken as seriously as it should be, and often after a devastating earthquake, the absence of academic knowledge and the proper application of seismic design principles in the architectural experience are painfully clear. Reduction of life-threatening injuries and building damages is the first reason for teaching sustainable designs against earthquakes to architects, and it should not be taught only in the field of engineering (Musavi, 2011).

There is very little evidence of the involvement of architects in the field of seismic design or research related to earthquake damage instructions. Despite the fact that seismic loading systems, because of their limiting ideas, influence architectural ideas, awareness of these limiting dimensions is essential for the architects; this awareness is realized by the integration of intellectual foundations of seismic design with architectural ideas (Amini et al., 2011).

2. Significance of the Study

As a developing country, Iran has a higher human losses in comparison with developed and even less developed countries in the event of an earthquake; five of the twenty recent earthquakes in the world have occurred in Iran (Mahdavi, 2005). One of the most disastrous earthquakes in our country goes back to the morning of the 5th of January 2003 in Bam; the Bam event, like those similar world-wide cases, could only be an important local or at most, a national news, not a global catastrophe (Mahdavi, 2005).

An earthquake, as a natural phenomenon, is risky and critical when the exposed community is vulnerable to it. An earthquake in one of the natural hazards for which there is always the probability of occurrence, especially when there are conditions for its occurrence, for example, multiple faults. Even some of the big cities are located on several active faults, and according to the historical records of these faults' activities, it can be said that one day in the near future, they will be faced with an earthquake and in the meantime, due to the presence of many faults and the vulnerability of these areas, the earthquake risk has increased (Ecom, 2003).

Another topic of importance is related to the driving roads and old textures, the low stability of which against earthquakes is one of the main characteristics of this type of urban texture. Another problem with this contexture is their inappropriate and limited access, which makes it difficult for their inhabitants to receive help after an earthquake, and this critical condition can lead to human tragedy. Therefore, based on what was previously mentioned, there is a vita need for assessing and analyzing the damaging and decreasing factors to help reduce the vulnerability of cities to earthquakes and acquire the required preparations for this natural risk. Therefore, continuous training of architects in the field of earthquake resistant design of structures is necessary for Iran (Musavi, 2005).

3. Literature Review

So far, several analyses and assessments have been made regarding the reduction of earthquake hazards, the assessment of earthquake vulnerability and the role of architects in various research; they can be classified into two categories of external and internal.

One of the most important measures taken to determine the physical vulnerability of buildings in Iran has been carried out by Tavakoli et al, in 1993, and the results of their studies have led to the estimation of failure curves for three different types of buildings, based on Rudbar and Manjil earthquakes. They studied the damage to the villages close to the center of the earthquake in Manjil and discovered the relationship between the history of the earth's acceleration and building damages.

Hatami Nejad (2009), using the analytical method for assessing seismic vulnerability and using AHP and GIS, investigated the vulnerability of District 10 in Tehran. For this purpose, they used such indicators as type of materials, structure lifetime, population density and communication network (Amini et al., 2011).

We should also mention the efforts of Dr. Mohammad Golabchi, a faculty member of the Architecture and Urbanism of Tehran University, in translating references in this field, such as Salvadori 19 and Fuller, and introducing concepts of structure to architects in simple language (Musavi, 2011).

Writing about structural skills in architecture expertise dates back to three years after the Mexico City earthquake disaster in 1985. "The earthquake was painfully struck down to us, and the basic system of the structure should be precisely out of the way through architectural education," says Cardnasas. This issue has been highlighted by Christopher Arnold and his colleagues.

An investigation of the constructions of a local royal service building in 1979 El Centro earthquake and the Olivio hospital building in 1971 earthquake of San Fernando explicitly confirmed that the idea of architecture might be more destructive than other decisions to stabilize buildings against earthquakes (Musavi, 2011).

Lantada et al. (2009), in a study, while modeling the vulnerability of Barcelona, using the RISK-UE model and the existing models in the estimation of damages, evaluated human and economic damages in the city of Barcelona (Lantada, 2009).

Tang and Van (2009) used an artificial intelligence system to assess the risk of an earthquake in Dian, China, on the development of GIS and artificial networks. This system is used to detect the seismic weakness of structures in pre-earthquake conditions to quickly assess the earthquake damage and to provide the conditions of urgent and smart public and governmental responses during and after the earthquake (Tang and Van, 2009).

By examining the research done, we can say that many studies have been carried out to evaluate and reduce the vulnerability of cities to earthquakes. Explaining the model and algorithm that can be used to analyze and assess the vulnerability of a city to an earthquake has a lot of benefits and significance. A model should be able to provide an accurate and understandable algorithm for assessing and analyzing vulnerability and estimating earthquake damage and provide appropriate solutions for the development of future construction in a city, based on the vulnerability of the area. It can be stated that the source of any scientific work is the questions that have engaged the mind of a scholar and the researcher by using the appropriate tools and methods, finds a logical answer to them in the process (Amini et al., 2011).

4. Damages Increment Factors

In general, factors such as low quality of building materials and low strength of buildings, high population density in worn-out structures, the presence of brick buildings that are highly vulnerable to strong vibrations, the proximity of residential structures to fault lines, and weakness in management during and after the earthquake make the incident a catastrophe (Mahdavi, 2005).

4.1. Weakness in Crisis Management

For example, a large part of the population of Bam city lived in its oldest structure, which was considered to be the worst and most vulnerable part of the city in terms of structure. This part of the city was completely destroyed by the earthquake. However, the activated fault in the Bam earthquake is located between the two cities of Bam and Burat. Unfortunately, despite the identification of this fault, the development direction of the city was selected to be toward the same fault. Finally, after the incident, the weakness in crisis management and preparedness, and the lack of an agreed agenda and instructions between relief agencies and forces dispatched to the region was very evident. In the Bam earthquake, due to the lack of education of the people, the absence of local relief and rescue organization, the lack of timely information and lack of organization in rescue and relief operations, the golden hours of relief were easily lost (Mahdavi, 2005).

4.2. Nonconformity to the Engineering Rules

Unfortunately, in the Bam event, even a number of new buildings with metal and concrete skeletons were destroyed, indicating the failure to observe the principles and rules of engineering in their design, supervision, and execution (Mahdavi, 2005).

5. How to Reduce Damages

Factors that Affect the Reduction of Damages

5.1. Retrofitting

In our country, the issue of retrofitting means increasing the level of buildings sustainability against earthquakes (rather than building a new earthquake-resistant building). It began after the occurrence of Manjil earthquake in June 1990. Until that incident, the term “retrofitting” was essentially unheard of in Iran, not only among the public but also among engineers. After the Manjil earthquake, which was the turning point in the history of earthquake engineering in Iran, a series of decisions were made on a national scale (Mahdavi, 2005). In relation to retrofitting, it can be said that every single building can be retrofitted, but the retrofitting of existing buildings is not practicable on a large and social scale. However, if our buildings were documented and the rules of regulations related to the year of construction were observed, it would only be necessary to reinforce some of the connectors. But in our country (Iran), in the foundation of more than 70% of the existing buildings, lime mortar has been used, and buildings are generally made out of wood or with masonry materials; therefore, the project of retrofitting existing projects is basically illogical (Mahdavi, 2005).

5.2. Reconstruction of Rusty Textures

Ghaffari states that "The debate on the reconstruction of rusty textures is a serious discussion that is practicable. We can gradually replace and reconstruct the rusty urban textures with new textures by a scheduled program".

5.3. Earthquake Scenario

The prediction of possible events and their effects is called scenario preparation. Scenario preparation often takes place in order to prepare plans and prepare for disasters in communities and helps to better understand the likely future. The earthquake scenario refers to the magnitude, severity and other parameters of the earthquake that the software considers as a possible earthquake in the region. The input parameters for the system to determine the earthquake scenario are the location of the earthquake, earthquake depth and the magnitude of the earthquake, because depending on the earthquake occurring at night or day, and the damage done to public buildings, schools and offices, the casualties and losses are completely different. Indeed, it should be noted that when an earthquake occurs, the effects and consequences of it will certainly differ greatly from the scenario's results. The scenario is only a hypothesis to know whether the effects of an earthquake are worse or similar to what the scenario has calculated (Amini et al., 2011).

5.4. Public Education and National Impetus

Except for technical books provided for engineers in this field, it is possible to present some books about seismology and retrofitting for the purpose of informing the public. By writing novels and making films that are informative about earthquakes, the knowledge and education in the field of earthquakes can be considered as a part of people's life, and in the field of social and media works, we need to be more serious and active to increase the awareness of people in this area (Mahdavi, 2005).

5.5. The Role of Architects in Reducing Damages

The subject of entering an earthquake-resistant design course to the architectural courses is highly discussed. This discussion initially began in the field of architectural design due to the destruction of the buildings during earthquakes because of incorrect decision making, and it was followed by critical reactions from the professional architecture community. Although another reason is the limiting ideas derived from the seismic loading system that forcibly affect architectural ideas, however, awareness of these limiting dimensions is imperative for architects (Bolt, 2002).

Architects have a great influence on the function of buildings against earthquakes and they are the first domestic professionals in the process of realization of a project and play a key role in the planning, design and implementation of that project. Architects are the only professionals who look at the full aspects of the design and implementation process of the project. They have a key role in choosing other specialists, especially the structural engineer, working closely with executives and organizing the project with the ultimate look in order to smooth the issues and achieve the desired results. Given that most of Iran's areas are located in areas with a high relative risk, improving the knowledge of architects in the field of earthquake-resistant design and the management of specialized groups in the process of designing and constructing buildings, reduces the vulnerability against earthquakes. Educational policy in advanced earthquake-prone countries is based on the

special attention to the earthquake-resistant design category. In contrast, the knowledge level of Iranian architecture graduates about seismic design indicates the weakness of the educational system in this field (Musavi, 2011).

Investigating the role of architects and the policy of architects society in advanced earthquake-prone countries suggest that architects have acquired many skills and are doing a lot of activities in accepting the following roles:

- Architects can take on specialized leadership roles in design teams and enhance the knowledge level of experts to reduce the risk and damage caused by the earthquake as much as possible.
- Architects are key members in the process of identifying earthquake-resistant design opportunities.
- Architects play a very important role in the retrieval and reconstruction of post-earthquake operations.
- Architects are key members of research teams whose goal is to use the latest technology in the process of reducing earthquake vulnerability.

The first decisions in the initial idea of project structure play a crucial role in its future resistance against earthquakes. Initial decisions may lead the project to a construction system or design idea in which it is difficult to achieve resistance to lateral forces. Hence, the reduction of vulnerability in architectural design is done by a series of measures that can be categorized into four general areas:

- Determining the ways in which architects should increase the resistance of buildings to earthquakes
- Explaining the relationship between designers and employers, executives, investors, etc. that can enhance the safety of building structures
- Promoting the role of architects in the evaluation of structures after an earthquake and the use of its instructions
- Determining educational needs based on the achievements of earthquake research institutions and the details of building construction in seismic areas

The uniqueness of each project depends on the designer skilled in conducting specialized judgment and all-around decisions of the consultant in the design and execution process. Architects must pay adequate attention to the scientific ideas and methods to succeed in enhancing the skills of earthquake-resistant design and adopt them to their personal approach. The upgrading options of design skills that are consistent with the earthquake are as follows:

- Participation in continuous training programs with social attention to the design and implementation of earthquake-resistant designs by designers, employers, and builders.
- Visiting areas stricken by an earthquake to investigate damages and study the behavior of sample structures
- Participation in the development of earthquake-resistant design guidelines and its compliant executive guidelines and assessment reports
- Development of formal interactions between engineers and architects in relation to the human and basic seismic design
- Development of the goals and expectations of the employer and the design team for the resistant design against earthquakes
- Examining the conceptual and schematic designs through the interaction between architects and engineers
- Compilation of defined service descriptions and balancing the responsibilities of architects, engineers, and executives

- Providing an independent team for reviewing and evaluating large scale specialist projects

Teaching structures to the architectural students will be successful when faculty members are interested in the subject. They should motivate students and more importantly, show the relationship of the lessons with architecture.

An appropriate educational environment occurs when various educational experiences are provided. Writing articles, holding discussion classes and meetings and dedicated teaching in design workshops are the most common methods used in seismic design training. Although these methods are old, they are still very effective. However, investigating the structures design education and the seismic design in Iran suggests that the professors are relying on theoretical education and learning theory of the design and also rely on the theoretical examination for student evaluation (Musavi, 2011).

6. Suggestions and Solution

We should examine the impact of various books on this area. In my opinion, seismological and earthquake engineering and especially retrofitting books are divisible in two groups of technical books and books designed to inform the public. When compared with the amount of work in other seismic countries with a high and medium relative seismic hazard, there has been little work in this field in our country. In Japan, as a seismic country, hundreds of novels have been written and thousands of films have been made which are semi-consciously about earthquakes. Basically, the awareness and education about earthquakes have become a part of their people's lives in this country. We need to be more active in social and media works to raise people's awareness of this phenomena and to remove people from their superstitious beliefs (Mahdavi, 2005).

We are among the countries which have a high range in the field of earthquake engineering. In all branches related to the study of earthquakes, experts and researchers are abundant. Therefore, in accordance with the basic concepts of earthquake engineering, which is fully reflected in these specialized bylaws, our buildings have to survive the strongest earthquake, although with minor damage (Shea, 1999).

In addition, we should consider that the construction design that blindly follows some seismic regulations does not guarantee safety against overturns or severe damages (Heynes et al., 1989).

7. Conclusion

Usually, according to the building regulations, the structures are designed to withstand the largest earthquake that may occur in that area. This means that casualties must be minimized by preventing the destruction of buildings. Architects should be aware of the role of structural components in architectural design quality. A decisive fact is that earthquake-resistant construction techniques are as important as quality control and the use of proper materials, since a structure even with complete stability is likely to be in danger of an earthquake occurrence.

Also, the comparison of the continuous training of architects in expert societies of Iran and America indicates the lack of continuous academic education of Iranian architects in professional environments and its role in the vulnerability of the cities and buildings of the country against earthquakes. Recognition of the architect's role in reducing earthquake hazards and its consistent design on one hand and describing the responsibilities of involved organizations and institutions, on the other hand, give suggestions and guidelines to policymakers, which leads to the strengthening of design and implementation mechanism that is compatible with the earthquake.

We should organize and develop common seminars between architects and engineers in the field of earthquake-resistant design with the aim of establishing communication between these two groups.

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