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Evaluating Earthquake Disaster Management in the Worn Urban Texture (Case Study: Farameh Neighbourhood, Damavand City)

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ABSTRACT: Urban vulnerability to environmental hazards in the countries with the natural and risky environment has been an important challenge in urban sciences, engineering sciences, management and urban planning. This study tries to emphasize influential role of urban planning indicators along with structural indicators of earthquake programs by presenting a method to analyze seismic vulnerability of worn textures, and intends to identify and develop the relationship between urban planning and earthquake disaster management, in order to reduce the seismic vulnerability of old texture of Farameh district in Damavand city. The significance of seismic vulnerability of Damavand city, especially worn textures and spaces of its central parts, regarding the natural unsecure bed and the position of central parts of the city, necessitate estimation of old (worn) textures of central parts of Damavand and prioritize offering instructions to reduce its seismic vulnerability. First, vulnerability position of Damavand city is studied emphasizing on Farameh district, and then Farameh neighborhood is introduced as study area of the research. In analysis level, first the amount and data of indicators are extracted and then weighing of these indicators are studied using Analytic Hierarchy Process (AHP) and Expert Choice. Finally, the design of construction vulnerability scenarios will be discussed, using the results obtained from the analysis of the indices in AHP model. It was concluded that expansion and population coverage of high and very high vulnerable areas is high (in central parts and core of the texture), and all in all it indicated high vulnerability of the areas regarding all analyzed physical factors against earthquake.

Keywords: Earthquake Vulnerability, Physical Indicators, Urban Planning, Disaster Management, Worn Textures, Farameh Neighborhood

INTRODUCTION

During twentieth century, more than 1100 destroying earthquake has occurred all around the world that causes death of more than 1500000 people, 90% of which was caused mainly by the collapse of buildings that were not secure enough (Lantada, 2008).

Due to the population growth and increasing urbanization, natural disasters like earthquakes can cause heavy losses and interrupt the development of cities and countries. Necessity of decreasing urban earthquake vulnerability is one of the main objectives of urban planning and physical planning. In this regard, first step is recognizing vulnerability of urban elements and its analysis using existing models in this context to recognize vulnerable urban areas and textures using these models and microzonate these areas to provide practical and scientific solutions (disaster management) to reduce earthquake impacts.

Analyzing seismic vulnerability of worn textures is one of the most significant and effective steps in developing program to reduce the effects of earthquakes in terms of disaster management plans (Ghafouri Ashtiani, 2001). This study intends to identify and develop relationship between urban planning and earthquake disaster management, to reduce earthquake vulnerability of worn texture of Farameh neighborhood, Damavand city. To this end, some micro subjects are studied such as: identification and selection of indicators to assess the seismic vulnerability, using AHP model to analyze impact of each indicator and determining risky and worn populated areas and ranking different types of vulnerability as research options (innovation in research), mapping seismic hazard zoning, designing vulnerability scenarios and estimation of construction and human casualty, and providing strategies and policies related to disaster management in the study area in order to reduce the damage and casualties caused by earthquake.

Research objectives

According to the original research subject and questions that arise from this issue, the main objective of this research can be formed as follow:

"evaluating seismic vulnerability of worn texture of Farameh neighborhood in Damavand city, using analysis of physical indicators and urban planning of neighborhood, designing different scenarios of construction and human casualties in various seismic intensities using related models, to make earthquake disaster management process more effective, appropriate guidance of earthquake impact reduction plans and providing strategies and policies to reduce seismic

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vulnerability of old texture of study area."

MATERIAL AND METHODS

This study can be regarded as analytical-exploratory research, while, due to the nature of the data and the impossibility of controlling the behavior of the influential variables in the problem, the study is non-experimental. In the first stage, data collection method is documentary and library, and reviewing literature on earthquake and its damage in urban areas, especially worn textures. In the next stage, neighborhood information is collected as a field work, statistical data, information of consulting engineers and subject related organizations are used. Therefore, vulnerability condition of Damavand is studied emphasizing Farameh neighborhood, and then the neighborhood is studied as study area of the research. In analysis step, first amount and data of all indicators are extracted, and then are weighed based on AHP and Expert Choice methods, and finally, referred to the design of construction vulnerability and human casualty scenarios using mean vulnerability degree model and Korben method, and using explored results of indicator analysis of AHP and Expert Choice model.

REVIEW OF LITERATURE

In relation with the analysis of earthquake disaster management in urban contexts with various methods, many projects are available in the form of practical projects, research and thesis of students, that are directly aimed to analyze seismic vulnerability of urban areas or any other purposes, such as providing strategies to reduce earthquake impacts and dangers.

Zahrani and Ershad (2005) investigated seismic vulnerability of constructions in Qazvin city. Results of their study indicate that most masonry buildings, particularly in the area 1 of the city and some of the steel and concrete buildings are vulnerable to serious damages against moderate and severe earthquakes, therefore, immediate action should be taken to assess their vulnerability and retrofitting.

Azizi and Akbari (2008) studied planning considerations in assessing urban vulnerability to earthquake (case study of Tehran Farahzad). Their study show that increasing variables such as land slope, population density, building density, longevity of buildings and distance from open spaces will increase vulnerability. While, increasing variables such as distance from the fault, the area of parts, access based on lane width, land uses compatibility in terms of proximity will reduce vulnerability and vice versa. Reducing earthquake vulnerability of cities in long term will achieve when urban immunity against earthquake risk be considered as a goal at all levels of planning.

Mohammad Zadeh (2009) studied urban planning experiences of Tokyo in decreasing earthquake vulnerability. He concluded that like other unexpected phenomena, earthquake is not repeated in Tokyo. In fact, after great earthquake of Kanto in 1923, Tokyo applied urban planning tools such as expanding open spaces, to decrease side effects of earthquake. However, in 1960-70s and 1980-90s, these tools coordinated with dominated planning instructions of the world and resulted in dramatic reduction of damages during recent years.

In their study "disaster management to control the damage caused by the earthquake in Tehran" Rashidi et al. (2011) indicated that Tehran has more potential to earthquake and according to the reverse and repetition of natural disaster law, possibility of occurring earthquake in Tehran is very high and predictable and vulnerable groups and critical points are physically match with area occupied with lower strata of society.

In another study "evaluation of seismic vulnerability in district 1 of Tabriz using multi-criteria spatial analysis" Kamel et al (2012) show that based on ultimate damage map, northern and eastern parts of the area are considered as critical areas based on possible earthquake vulnerability. Adjacency to the fault, increasing land slope, worn texture of the buildings, and lack of appropriate accessibility to urban street network are respectively the most significant factors in increasing damages of earthquake in the area.

In his study "disaster mitigation the concept of vulnerability revisited", Weicheselener (2009) believes in multidisciplinary review of the vulnerability to natural disasters and in this process give priority to identifying disaster and its impact on community development.

Study area

In the past, Damavand city was known as "realm of Damavand"; it was not the name of city or village, but a territory. Damavand city is located in Tehran province with an approximate distance of 70 km from it, in 52°, 3´ of east longitudinal and 35° and 43´ of north latitudinal. The city's height above sea level is about 2000 meters. In general, Damavand city is one of the summer areas surrounding Tehran and is located in the hillside of Damavand Mountain. Due to its geographical position, summer place, and locating on main road of Tehran-FirouzKouh-Mazandaran, it has expanded significantly especially in Gilavand area.

In general, main core of Damavand in the pas included Qazi, Darvish, Farameh and Chalka neighborhoods, and other small and big neighborhoods were located outside the Damavand city, many farms and rivers naturally extend these scatterings. These villages are then added to Damavand city and expanded the city (Sharmand advisory engineers, 2005)

According to the governmental divisions in 1937, Damavand became as part of Tehran city and in October 1346 was converted into a city. Damavand city was in the central part of Tehran city.

Farameh neighborhood

It was considered as one of the old neighborhoods of the city, and a part of old and traditional texture of Damavand city located in northern part of Farameh neighborhood. The neighborhood with an area of 213.3 hectares is located approximately in the center of Damavand city and Imam Khomeini Street stretches from south to north of the neighborhood. This neighborhood along with Qazi, Darvish, and Chaleka neighborhoods are accountable for serving to northern parts of Damavand city. Except old and traditional texture constructed before Islamic revolution of Iran, all other buildings of the neighborhood are constructed after revolution. Like other neighborhoods, main part of the neighborhood constitutes of gardens and farmlands, and residential texture is located in the north and north-east.

Chart 1. Analyzing seismic vulnerability of neighborhood

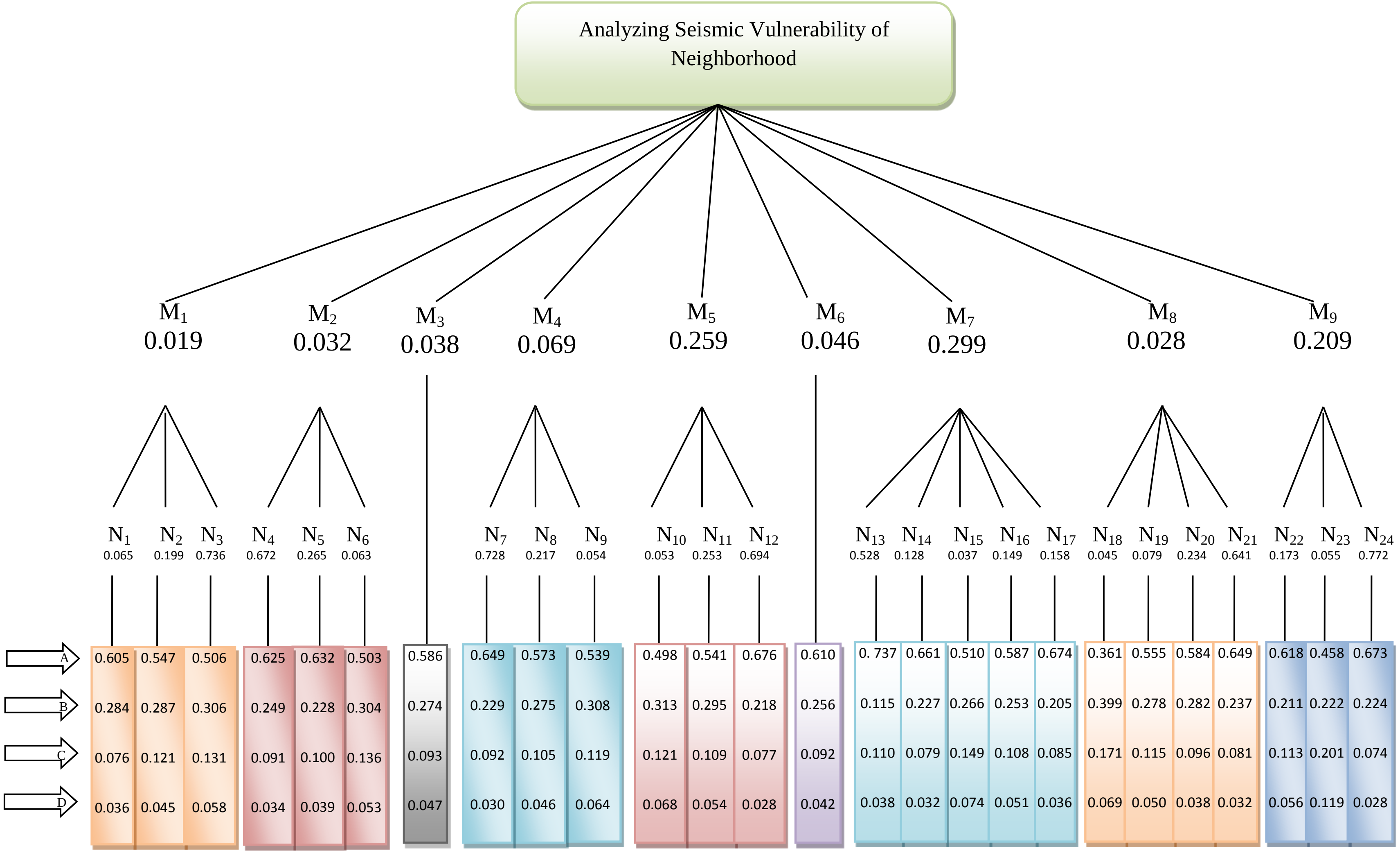

Table 1. Final scores of options

criteria	size M_1			land use M_2			population density M3	accessibility and street network M_4			date of constructions M_5			distance from fault M_6	quality of buildings M_7					number of floors M_8				type of structure material M_9			final scores of the options
sub-criteria / options	N_1	N_2	N_3	N_4	N_5	N_6		N_7	N_8	N_9	N_{10}	N_{11}	N_{12}		N_{13}	N_{14}	N_{15}	N_{16}	N_{17}	N_{18}	N_{19}	N_{20}	N_{21}	N_{22}	N_{23}	N_{24}	
A	0.065	0.199	0.736	0.672	0.265	0.063	-	0.728	0.217	0.054	0.053	0.253	0.694	-	0.528	0.128	0.037	0.149	0.158	0.045	0.079	0.234	0.641	0.173	0.055	0.772	0.6364
	0.019	0.019	0.019	0.032	0.032	0.032	0.038	0.069	0.069	0.069	0.259	0.259	0.259	0.046	0.299	0.299	0.299	0.299	0.299	0.028	0.028	0.028	0.028	0.209	0.209	0.209	
	0.605	0.547	0.506	0.625	0.632	0.503	0.586	0.649	0.573	0.539	0.489	0.541	0.676	0.610	0.737	0.661	0.510	0.587	0.674	0.361	0.555	0.584	0.649	0.618	0.458	0.673	
B	0.065	0.199	0.736	0.672	0.265	0.063	-	0.728	0.217	0.054	0.053	0.253	0.694	-	0.528	0.128	0.037	0.149	0.158	0.045	0.079	0.234	0.641	0.173	0.055	0.772	0.2137
	0.019	0.019	0.019	0.032	0.032	0.032	0.038	0.069	0.069	0.069	0.259	0.259	0.259	0.046	0.299	0.299	0.299	0.299	0.299	0.028	0.028	0.028	0.028	0.209	0.209	0.209	
	0.284	0.287	0.306	0.249	0.228	0.304	0.274	0.229	0.275	0.308	0.313	0.295	0.218	0.256	0.115	0.227	0.266	0.253	0.205	0.399	0.278	0.282	0.237	0.211	0.222	0.224	
C	0.065	0.199	0.736	0.672	0.265	0.063	-	0.728	0.217	0.054	0.053	0.253	0.964	-	0.528	0.128	0.037	0.149	0.158	0.045	0.079	0.234	0.641	0.173	0.055	0.772	0.1778
	0.019	0.019	0.019	0.032	0.032	0.032	0.038	0.069	0.069	0.069	0.259	0.259	0.259	0.046	0.299	0.299	0.299	0.299	0.299	0.028	0.028	0.028	0.028	0.209	0.209	0.209	
	0.076	0.121	0.131	0.091	0.100	0.136	0.093	0.092	0.105	0.119	0.121	0.109	0.077	0.092	0.110	0.079	0.149	0.108	0.085	0.171	0.115	0.096	0.081	0.113	0.201	0.074	
D	0.065	0.199	0.736	0.672	0.265	0.063	-	0.728	0.217	0.054	0.053	0.253	0.694	-	0.528	0.128	0.037	0.149	0.158	0.045	0.079	0.234	0.641	0.173	0.055	0.772	0.0324
	0.019	0.019	0.019	0.032	0.032	0.032	0.038	0.069	0.069	0.069	0.259	0.259	0.259	0.046	0.299	0.299	0.299	0.299	0.299	0.028	0.028	0.028	0.028	0.209	0.209	0.209	
	0.036	0.045	0.058	0.034	0.039	0.053	0.047	0.030	0.046	0.064	0.068	0.054	0.028	0.042	0.038	0.032	0.074	0.051	0.036	0.069	0.050	0.038	0.032	0.056	0.119	0.028	

As it is indicated in seismic vulnerability analysis chart of the neighborhood, the parameters were first compared binary and their final weight was calculated. Results of the chart indicate that quality of constructions gain the highest amount (0.299) that represents the high importance of the criteria in neighborhood vulnerability. The issue indicates too worn out buildings and the high vulnerability of buildings in the neighborhood. Buildings dating and structures and materials types gain 0.259 and 0.209, respectively and are in the next priorities. Thus, it is observed that the physical standards of buildings and constructions have the most impact in the vulnerability of the study area. Urban planning criteria such as street network, population density and land use with scores of 0.069, 0.038 and 0.032 are respectively in the following priority areas influential on vulnerability analysis, that indicate the impact of non-structural factors on neighborhood vulnerability.

Then, sub criteria of each criteria was compared binary and their weight was calculated, and finally each 4 options were compared binary to all criteria and sub-criteria of the research and their final score was determined (table 1).

Importance coefficients of criteria, sub-criteria and all options in hierarchy structure of final score determining is presented in table 3-5 based on principle of hierarchical composition using the importance coefficients.

Final score of the options indicate that option A with 0.6364 scores is in the top place compared to other options and B with 0.2137, C with 0.1778 scores are placed in next stages respectively and D with 0.0324 scores is the least prior option. Analyzing all indicators and sub-indicators of the research using AHP and considering high score of option A and its significant difference with other options, indicate high vulnerability of the neighborhood.

Analyzing vulnerability of constructions in Farameh neighborhood

Results of analyzing different damage rates according to three different scenarios in 6, 7, and 8 mrcali indicate that damages to the constructions are different in neighborhood, thus, from total of 2558 constructions in 6 mercali damage intensity, most of the constructions, about 90% (2481 buildings) were with minor, ignorable and average vulnerability and very little percent of the constructions had heavy damages. In 7 mercali intensity, vulnerability of the neighborhood increases to 12.09% of constructions with minor and ignorable damages, 35.06 with average, and 30.37% with considerable to heavy damages, 10.63% very heavy damages and 11.86% of the constructions were destroyed completely. Neighborhood vulnerability also increases in 8 mercali: 6.2% of constructions with minor and ignorable damages, 3.67% with average, 8.51% with considerable to heavy damages, 28.13% very heavy damages and 53.51% of the constructions were destroyed completely.

Thus it is observed that increasing mercali from 6 to 8 intensities, neighborhood vulnerability increases so that about 80% of constructions that were with minor or ignorable damages in 6 mercali were destroyed completely in 8 mercali. Excessive difference in neighborhood vulnerability against three scope and intensity of the earthquake is mainly due to the excessive worn out and long life span of the constructions and using less durable materials, which are mostly considerable in central parts. Therefore, it can be concluded that high vulnerability of central core of the neighborhood in the possible earthquake has more human casualties than surrounding areas.

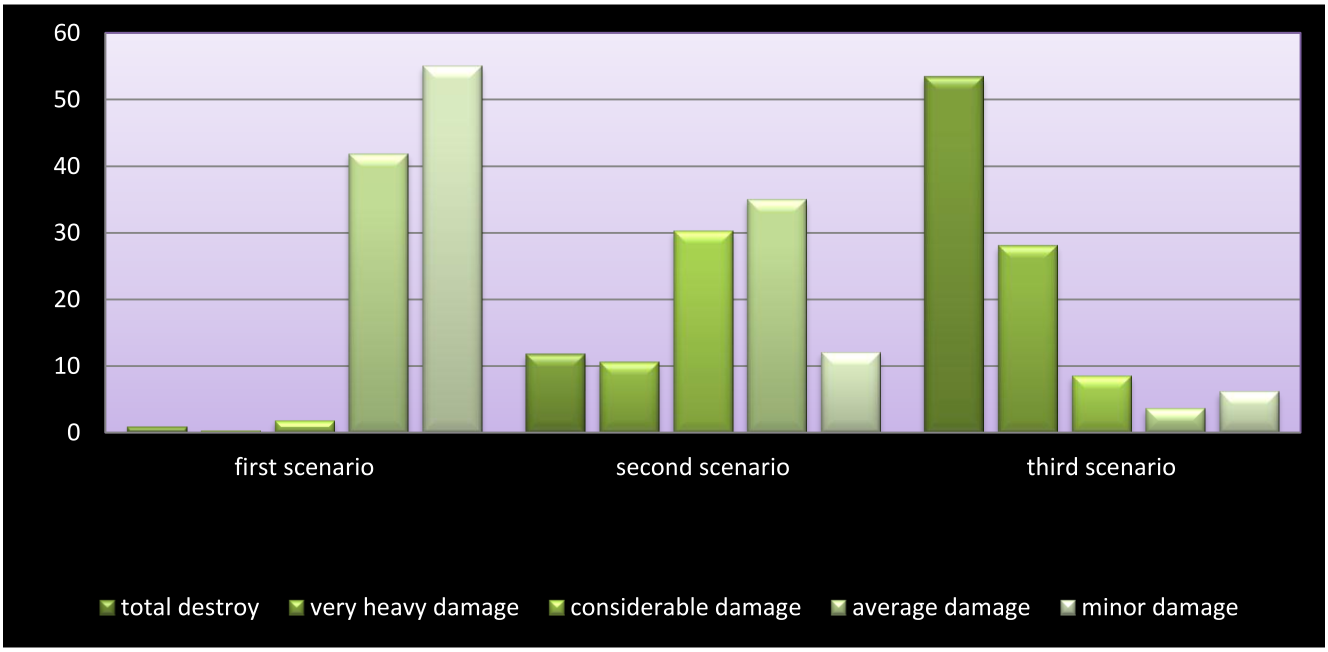

Table 2. Construction vulnerability of neighborhood against different intensities of earthquake

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RESULTS AND CONCLUSION

- Based on the objectives and hypothesis of the study it is concluded that:
- Seismic vulnerability evaluation scenarios are different according to the changes in characteristics of under study area, time, available resources and practical objectives.
- In evaluating vulnerability, using structural indicators alone can't be sufficient; to achieve more accurate results, other indicators such as population density, texture of understudy area, street network, and their relation with open and close spaces are also necessary.
- Considering views and approaches of urban vulnerability analysis
- Analyzing urban physical elements to achieve vulnerability criteria
- Using AHP method as a flexible model in evaluating urban vulnerability against earthquake
- Defining different scenarios regarding general vulnerability and earthquake intensity to evaluate damages to urban buildings of the neighborhood
- Evaluating and estimation of damages to urban buildings against different intensities of the earthquake
- Evaluation and estimation of human causalities in different intensities of the earthquake

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