SEISMIC DAMAGE AND DISASTER MANAGEMENT MAPS OF THE CITY OF GACHSARAN

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ABSTRACT :

There exist many cities in developing countries which are built with minimal seismic considerations. Also, due to the expenses regarding in detailed and analytical identification of such vulnerable buildings and structures in these cities, it seems that a rapid and inexpensive solution for assessment of a general understanding of the vulnerability of such cities is required for disaster management planning. In this regards, in this study a simplified evaluation form was developed in order to assess the key seismic vulnerability parameters of the buildings and structures in city of Gachsaran located along the Zagrous mountain range in Iran. Based on the gathered information, a data bank was created and using the generalized physical vulnerability functions developed for typical Iranian buildings, then a series of scenario base damage maps for the city was created. Using these maps, and available resources, a series of disaster management planning maps were created for different levels of potential hazard. These simplified procedure used for underdeveloped cities such as Gachsaran has established preliminary needs for planners while more sophisticated methods can be utilized. In this paper, method used will be discussed and results obtained will be presented. It is believed; this simple solution can be utilized in similar cases throughout the world.

KEYWORDS: Seismic, Management Planning, Vulnerability, Disaster

1. INTRODUCTION

Iran is a country with high seismicity. There exist many cities and towns around the nation which are built with minimal seismic considerations. Due to the earthquake activity of the country and poor construction, devastating situation are created after each earthquake. To this extend, one can remember the recent earthquakes of northern Iran and Bam earthquake in Kerman province. These quakes caused many casualties and enormous damages, more so creating a major problem in disaster management planning for the officials.

Study of recent earthquakes around the world especially in developing countries and underdeveloped nations also have revealed in similar problems. It seems due to the expenses regarding in detailed and analytical identification of such vulnerable buildings and structures in these cities, a rapid and inexpensive solution for assessment of a general understanding of the vulnerability of such cities is required for disaster management planning.

In this regards, in this study a simplified evaluation form was developed in order to assess the key seismic vulnerability parameters of the buildings and structures in city of Gachsaran located along the Zagrous mountain range in Iran. Figure-1 shows the location of this city in Iran. Based on the gathered information, a data bank was created and using the generalized physical vulnerability functions developed for typical Iranian buildings, then a series of scenario base damage maps for the city was created. Using these maps, and available resources, a series of disaster management planning maps were created for different levels of potential hazard. These simplified procedure used for underdeveloped cities such as Gachsaran has established preliminary needs for planners while more sophisticated methods can be utilized. In this paper, method used will be discussed and results obtained will be presented. It is believed, this simple solution can be utilized in similar cases throughout the world while financial and expertise are being developed for more sophisticated evaluation studies.

Figure 1 Location of City of Gachsaran

2. SEISMICITY OF GACHSARAN

Gachsaran is located in southern section of Iran along the Zagrous mountain Ranges. Figure-2 shows seismicity of the city by indicating study radius. According to hazard study, results of peak ground accelerations are provided in Table-1 [Nateghi, 2004]. As seen, it was concluded that the city is potentially located in high to moderate seismic zone causing concerns for the city officials.

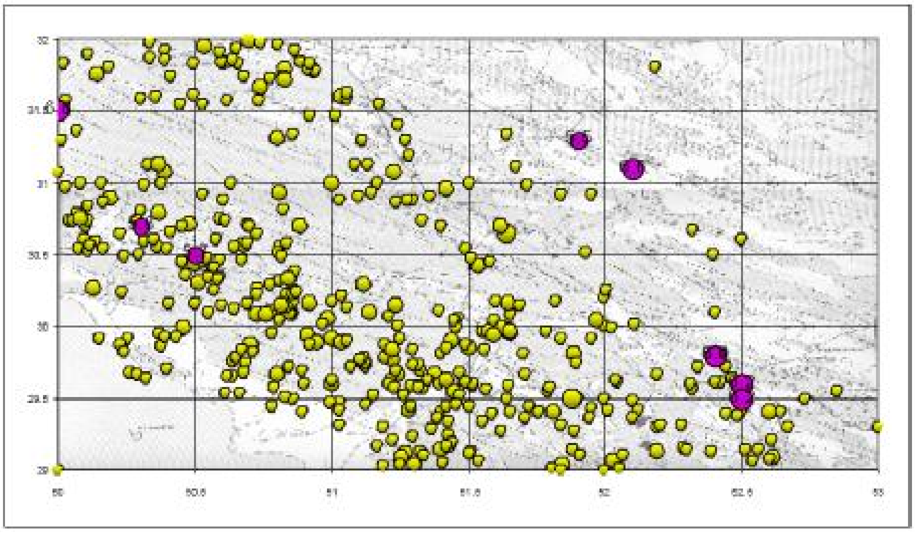

Figure 2 Seismicity of Gachsaran

Table 1 PGA Calculations for the city

Site Class : Rock				
	ONE SEISMIC REGION AND ZARE99 ZAGROS ATTENUATION RELATIONSHIP			
hPGA	Design Level	Return period	Risk Prob.	Useful life
0.217618	OBE	50	64%	
0.239181	MDE	75	50%	50
0.35915	MPE	475	10%	
	SIX SEISMIC REGION AND ZARE99 ZAGROS ATTENUATION RELATIONSHIP			
hPGA	Design Level	Return period	Risk Prob.	Useful life
0.20159	OBE	50	64%	
0.21644	MDE	75	50%	50
0.32885	MPE	475	10%	
	SIX SEISMIC REGION AND ZARE99 IRAN PLATEAU ATTENUATION RELATIONSHIP			
hPGA	Design Level	Return period	Risk Prob.	Useful life
0.22043	OBE	50	64%	
0.22067	MDE	75	50%	50
0.3252	MPE	475	10%	
	SIX SEISMIC REGION AND Boore1981& Joyner			
hPGA	Design Level	Return period	Risk Prob.	Useful life
0.23415	OBE	50	64%	
0.25644	MDE	75	50%	50
0.37993	MPE	475	10%	

3. EVALUATION FORM

An evaluation form was derived for information gathering of the buildings throughout the city. A quick study of literature revealed many forms and recommendations for rapid visual screening techniques. In this study ATC, FEMA, Canadian Forms, Yugoslav Forms and Iranian Forms were studied. Based on these forms and construction techniques used in the region, a simple form was devised. Main questions in these forms consist of questions regarding; general information, structural types and deficiencies, soil conditions, number of stories, pounding possibilities and irregularities as well as questions concerning disaster management plans. Numbering techniques was used for the evaluation. These values were selected from FEMA recommendations also were calibrated to the local conditions as shown in the form.

4. DATA COLLECTION

A team of 12 civil engineering local college students were selected and trained for the data collection. Two team leaders; graduate earthquake engineering students were selected for training and data processing. Two workshops were conducted for training. City was divided into grids and students were sent to different grids. A form was filled out by the students in accordance to the directions given in the workshops for each building. At the end of each day, students and their forms were collected and placed into a data bank. To minimize personal judgment errors, all gathered data was checked before placing into the bank. A typical filled out form for a typical building of Figure-3 is shown in Figure-4.
Each building was photographed. Deficiencies and degradations were specially photographed. Figures 5 show typical problems encountered throughout the data gathering. More than 10,000 buildings were studied by this team in less than a month. Use of data bank also enabled the investigators to derive in different enquires. These inquire also provided a closer look at the city's construction and its deviations from the local building code (Iranian Seismic 2800 Standard). Table-2 shows some of the results provided in table form. [Nateghi, 2006] and [Dehghani, 2004].

Figure 3 Typical building subjected to evaluation form

کروکی سازه:

A1 - 20

آدرس:

سال ساخت: ۱۳۷۵	تعداد طبقات: ۱ ☐ ۲ ☐ ۳ ☐ ۴ ☑ ۵ ☐ ۶ ☐ ۷ ☐ ۸ ☐
زیرزمین: دارد ☐ ندارد ☑	مساحت تقریبی: ۴۰۰ - ۳۵۰
تیپ سازه: فولادی ☑ بتنی ☐ آجری ☐	نوع سازه:
تعداد افراد: ۱۰ - ۱۲	مشکل اقلام غیرسازه ای: دارد ☑ ندارد ☐

مقاوم ☑ غیر مقاوم ☐ آسیب پذیر ☐ زوال مصالح: بلی ☐ خیر ☑

توضیحات:

ارزیاب:

STRUCTURAL SCORES AND MODIFIERS

BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Basic Score	4.5	4.5	3.0	5.5	3.5	2.0	3.0	1.5	2.0	1.5	3.0	1.0
High Rise	N/A	-2.0	-1.0	N/A	-1.0	-1.0	-1.0	-0.5	N/A	-0.5	-1.0	-0.5
Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-0.5	-0.5	-1.0	-1.0	-0.5	-0.5
Soft Story	-1.0	-2.5	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-2.0	-2.0	-1.0
Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
SL3	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
SL3& 8 to 20 Stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8

FINAL SCORE + 4.2

Figure 4 Typical form filled out at the site

Figure 5 Soft story due to elimination of bracing in first story

Table 2 Construction Inventory of the City of the Gachsaran

	FRAME	FRAME	MASONRY	MASONRY	MASONRY	STRUC.TYP
Tot. no.	BRACED	R/C	CONC.BLOCK	TILE	STONE	
3440	968	296	813	1267	96	safe
32.13	50.00	89.97	20.00	39.98	7.95	%safe
7267	968	33	3252	1902	1112	Vulnerable
67.87	50.00	10.03	80.00	60.02	92.05	%Vulnerable
10707	1936	329	4065	3169	1208	Total
100	18.08	3.07	37.97	29.60	11.28	Total Percent

5. DEVELOPMENT OF VULNERABLITY AND DISASTER MANAGEMENT PLANNING MAPS

After collecting more than 10,000 data forms and creating a data bank, information gathered then was applied to generate the vulnerability and disaster management planning maps. Three levels of vulnerability were defined namely, red, yellow and green indicating very vulnerable, moderately vulnerable and relatively safe buildings. These Maps are shown in Figures 6 to 7. Based on these potentially vulnerable zones and resources available such as hospitals, fire stations, water tanks, food storage and.… a generalized disaster planning map was derived as shown in Figure-10. This map has created enough information for the planners to work around the subject while more sophisticated techniques of evaluation can be devised. As shown, different locations are specified for different plans such as temporary shelter and so on.

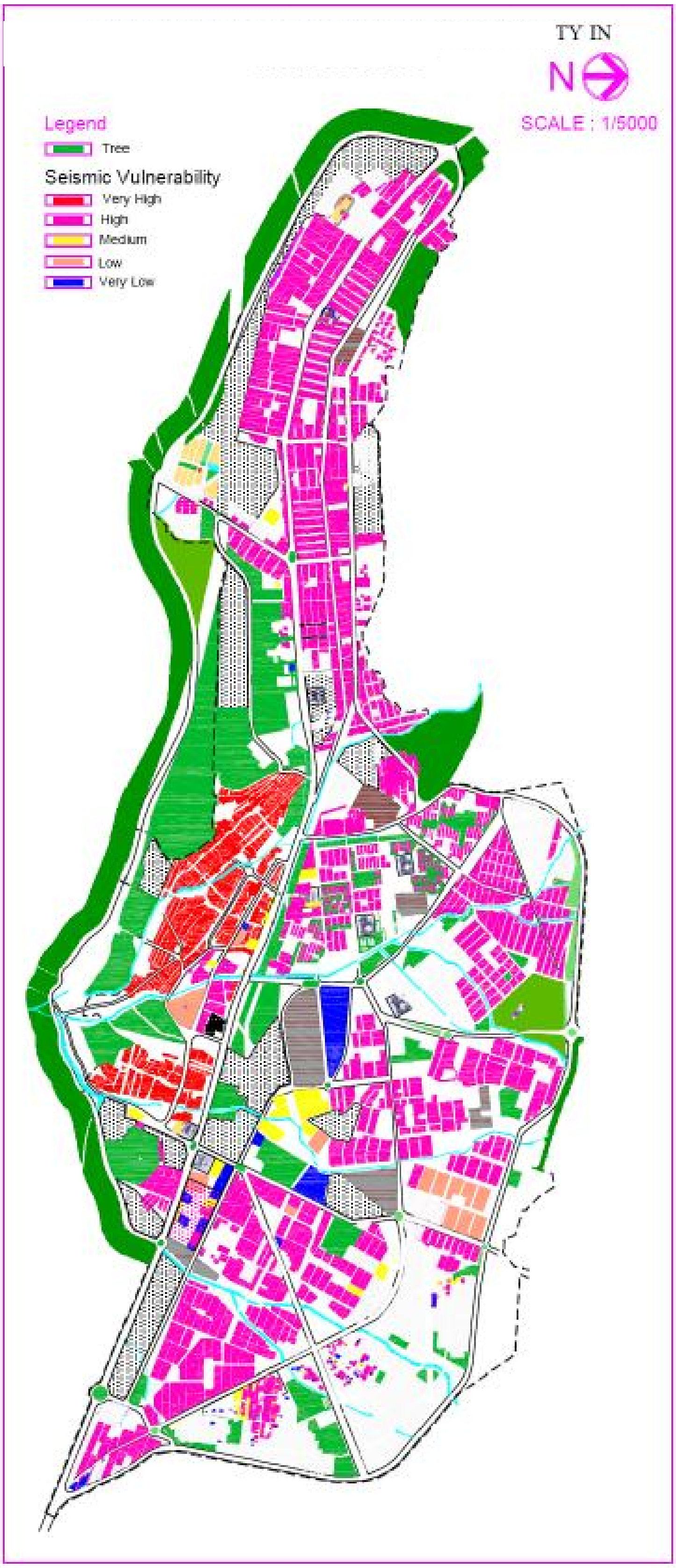

Figure 6 Construction qualities and vulnerability in city of Gachsaran

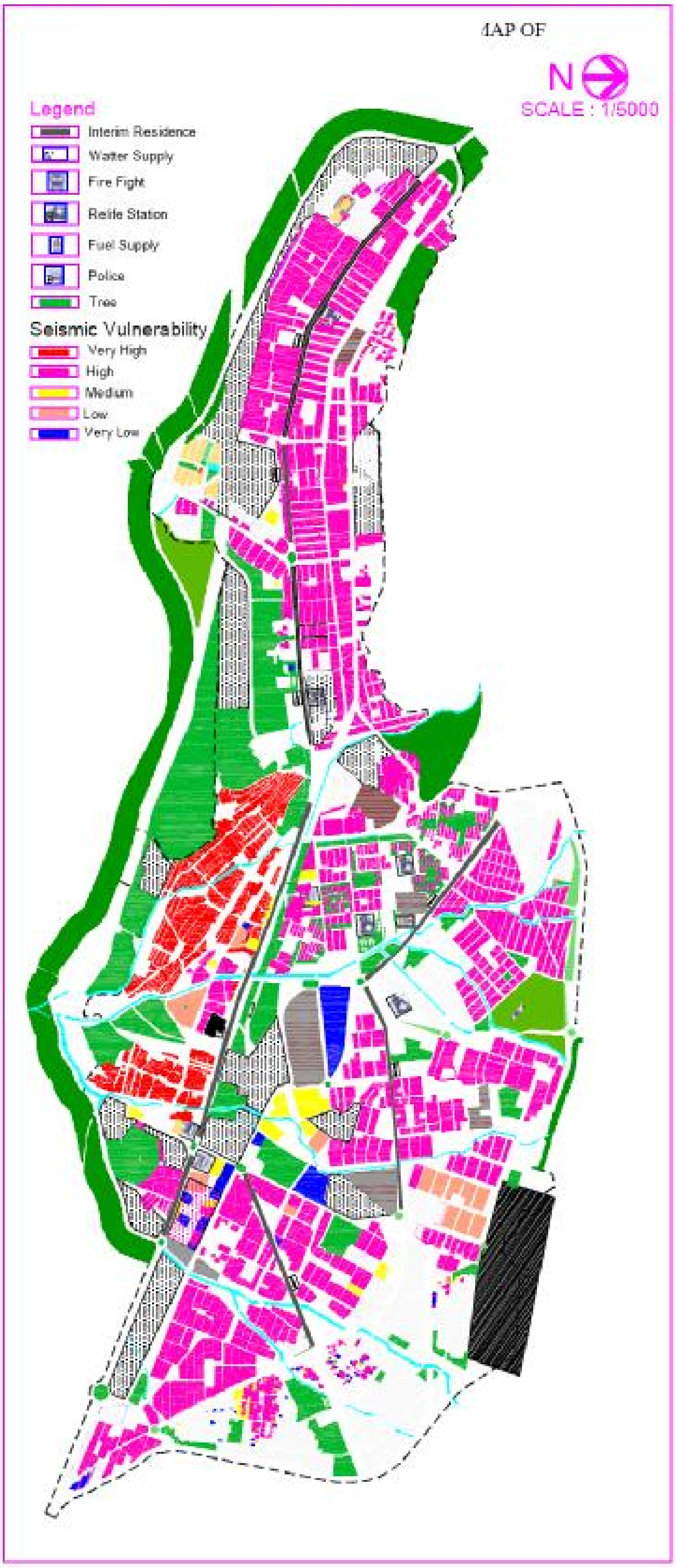

Figure 7 Proposed disaster management planning map for city of Gachsaran

6. CONCLUSIONS

A city with 15,000 buildings has been evaluated for potential seismic hazard using simple evaluation technique by the help of 12 college students. This technique used qualitative procedure by data gathering and visual screening methods. It is true that the technique used, possess some errors, however for cities and towns that lack enough financial resources or technical expertise, it promises quite sufficient planning tools. It seems that city planners can work with these preliminary maps to develop their strategic plans while waiting for more resources for better estimate of their vulnerabilities and need assessment. Many under privileged cities and towns throughout the world can benefit from this simple form of evaluation especially for the planning phase.

REFERENCES

Dehghani, A., Nateghi, F., (2004), "Development of Seismic Vulnerability Maps", Final Report No. 101/02, Tehran, Iran.

Nateghi, F., (2004), "Damage Potentials in City of Yasuj", Final Report Presented to the Ministry of Housing, Kohgheloyeh va Bouyer Ahmad Province, 2000 Pages.

Nateghi, F., (2006), "Evaluation Scores and Modifiers for Iranian Buildings", 7th Civil Engineering International Conference, ICCE 2006, Tehran, Iran

Zuccaro, G., Papa, F,. (2006). "Method of Seismic Vulnerability and Exposure Assessment at National Scale-The Italian Case", 12th European Conference on Earthquake Engineering, Paper No. 698.

"ATC-21, Rapid Visual Screening of Building for Potential Seismic Hazards: A Handbook". Federal Emergency management Agency, Washington, April 1998.