SEISMIC DAMAGE AND DISASTER MANAGEMENT MAPS (A CASE STUDY)

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Abstract There are many cities in developing countries that are built with minimal seismic considerations. Also, due to the expenses involved regarding detailed and analytical identification of such vulnerable buildings and structures in these cities, is very difficult and also time consuming. It is necessary and much needed to have a quick and inexpensive solution for such assessment in cities with the above mentioned criterion, for disaster management planning. Therefore this paper offers a study of a simplified evaluation form which was developed in order to assess the key seismic vulnerability parameters of buildings and structures in the 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 which was developed for typical Iranian buildings, a series of scenario based 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 procedures are used for underdeveloped cities such as Gachsaran to establish preliminary needs for planners, while more sophisticated methods can be utilized. The method used in this paper will be discussed and results obtained will be presented. It also is believed that, this simple solution can be utilized in similar cases throughout the world.

Keywords Disaster, Management, Earthquake, Structures, Map, Vulnerability

چکیده ساختمان های زیادی در کشورهای در حال توسعه وجود دارد که الزامات طراحی و اجرایی لرزه ای در مورد آنها رعایت نشده است. به علاوه ارزیابی آسیب پذیری لرزه ای ساختمان ها و سازه های موجود در اینگونه شهرها، به صورت تحلیلی و با جزئیات کامل بسیار وقت گیر و پرهزینه می‌باشد. بنابراین به راه حلی سریع و عملی با یک نگاه کلی برای ارزیابی آسیب پذیری این گونه شهرها جهت برنامه ریزی مدیریت بحران نیاز است. به این منظور، در این مطالعه برای ارزیابی آسیب پذیری لرزه ای ساختمان ها و سازه های موجود در سطح شهر گچساران که در مجاورت رشته کوه های زاگرس در ایران واقع شده است، فرم ارزیابی ساده و کارآمدی بر اساس پارامترهای مهم آسیب پذیری لرزه ای تهیه شده و از آن بانک داده های مورد نیاز استخراج شده است. سپس توابع آسیب پذیری کلی برای هر کدام از انواع ساختمان ها بسط داده شده و در پایان نقشه های آسیب پذیری شهر تهیه گردیده است. با بکارگیری این نقشه ها و منابع موجود، نقشه های برنامه ریزی مدیریت بحران برای سطوح مختلف خطر ترسیم شده است. با استفاده از چنین روش های ساده و کارآمدی برای شهرهای در حال توسعه مانند گچساران، ملزومات و توصیه های اولیه برای برنامه ریزان شهری در دسترس آنها قرار خواهد گرفت. در این مقاله روش مورد استفاده توصیف شده و نتایج به دست آمده شرح داده می‌شود. مولفان بر این باورند که می‌توان در موارد مشابه در نقاط مختلف جهان از این روش استفاده کرد.

1. INTRODUCTION

Iran is a country with high seismicity. There are many cities and towns around the nation which are built with minimim seismic considerations. Due to the earthquake activity of the country, the poor construction, create devastating situations after each earthquake. Keeping the above in mind, one can remember the recent earthquakes of northern Iran and also 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.

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

In this regards, a simplified evaluation form was developed in order to assess the key seismic vulnerability parameters of the buildings and structures in the 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 developed for typical Iranian buildings, a series of scenario based, damage maps for the above 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 the preliminary needs for planners while more sophisticated methods can be utilized. In this paper, method used will be discussed and the results will be presented.

It is believed that, this simple solution can be utilized in similar cases throughout the world while finance and expertise are being developed for more sophisticated evaluation studies.

2. SEISMICITY OF GACHSARAN

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

3. EVALUATION FORM

An evaluation form was derived for gathering the buildings information 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 regions, a simple form was devised. Main questions in these forms consisted of; general information, structural types and deficiencies, soil conditions, number of building 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 college students (local civil Eng, dept.) 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, the forms were collected and the information were placed in 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 in detail. Figures 5 to 7 show typical problems encountered throughout gathering the data. More than 10,000 buildings were studied by this team in less than a month. The use of data bank also enabled the investigators to derive different enquires. These inquires 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 [3] and Dehghani [1].

Figure 1. Location of city of gachsaran.

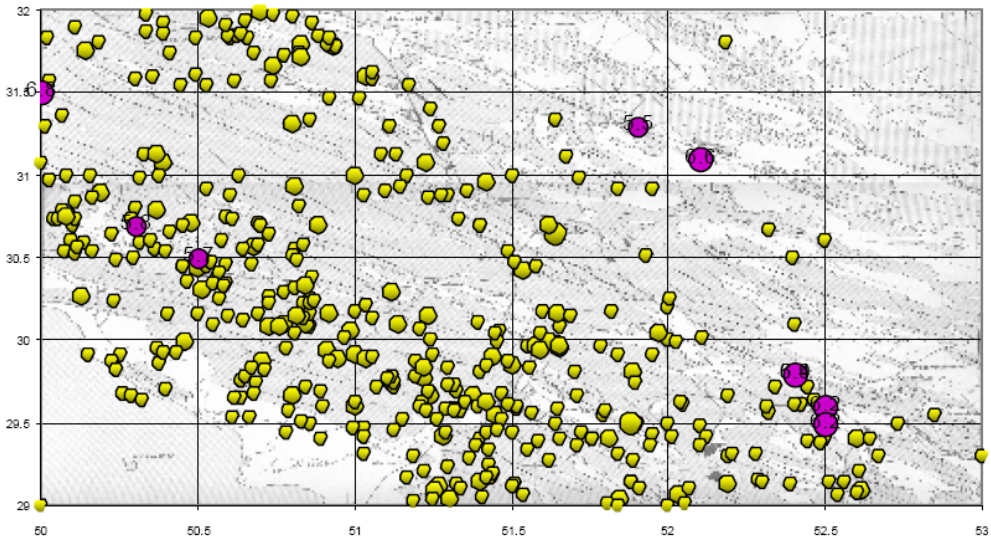

Figure 2. Seismicity of gachsaran.

5. DEVELOPMENT OF VULNERABLITY AND DISASTER MANAGEMENT PLANNING MAPS

After collecting more than 10,000 data forms and creating a data bank, the information gathered was applied to generate the vulnerability and disaster management planning maps. Three levels of vulnerability were defined namely, red, yellow and green indicating high (very vulnerable), mediom (moderately vulnerable) and low (safe buildings) respecttively. These Maps are shown in Figures 9 and 10. Based on these potentially vulnerable zones and available resources such as hospitals, fire stations, water tanks, food storages, a generalized disaster planning map was created as shown in Figure-10. This map gives enough information, for the planners to work on the subject while more sophisticated techniques of evaluation can be devised.

TABLE 1. PGA Calculations for the City.

Site Class: Rock				
One Seismic Region and Zare 99 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 Zare 99 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 Zare 99 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 Boore 1981 and 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 %	

Figure 3. Typical building subjected to evaluation form.

آدرس:

کروکی سازه:

A1 – 20

سال ساخت: ۱۳۷۵ — تعداد طبقات: ۱ ☑ ۲ ☑ ۳ ☑ ۴ ☐ ۵ ☐ ۶ ☐ ۷ ☐ ۸

زیرزمین: دارد ☐ ندارد ☐ — مساحت تقریبی: ۳۵۰ – ۲۵۰

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. Effect of moisture on the building.

Figure 6. Torsion due to different stiffness around the building.

Figure 7. Soft story due to elimination of bracing in first story.

As shown, different locations are specified for different plans such as temporary shelter and so on. Methodology and scope of the work are illustrated in Figure 8.

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 uses 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 financial resources or technical expertise, it promises sufficient planning tools. It seems that city planners can work with these preliminary maps to develop their strategic plans while waiting for other resources to better estimate their vulnerabilities and other needs. Many under privileged cities and towns throughout the world can benefit from this simple form of evaluation especially for the planning phase.

TABLE 2. Construction Inventory of the City of the Gachsaran.

Tot. No.	Frame Braced	Frame R/C	Masonry Conc. Block	Masonry Tile	Masonry Stone	Struc. Typ.
36440	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	3196	1208	Total
100	18.08	3.07	37.97	29.60	11.28	Total Percent

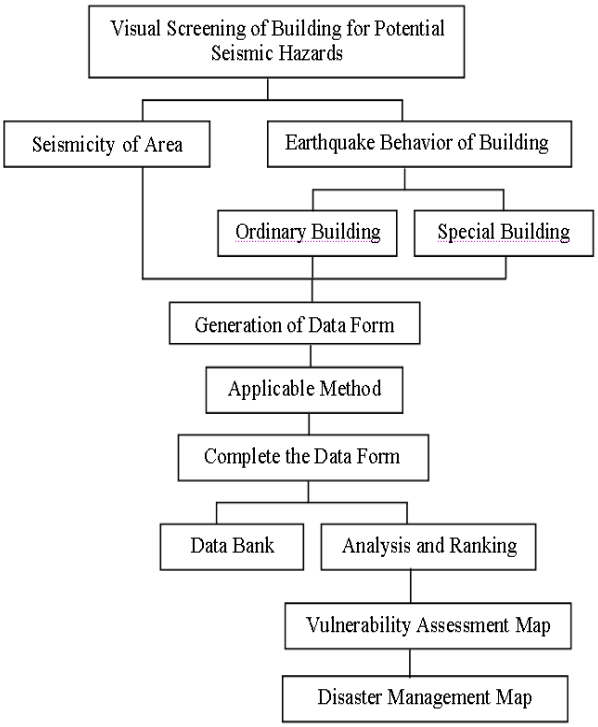

Figure 8. Scope of the work.

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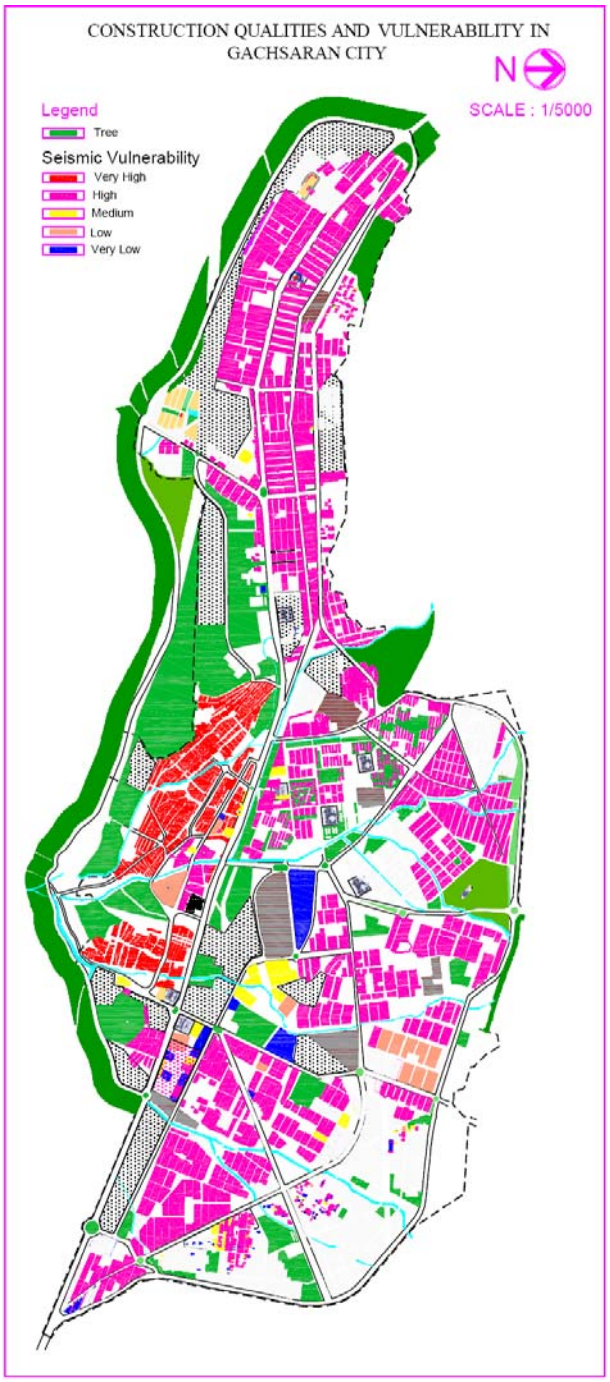

Figure 9. Construction qualities and vulnerability in city of gachsaran.

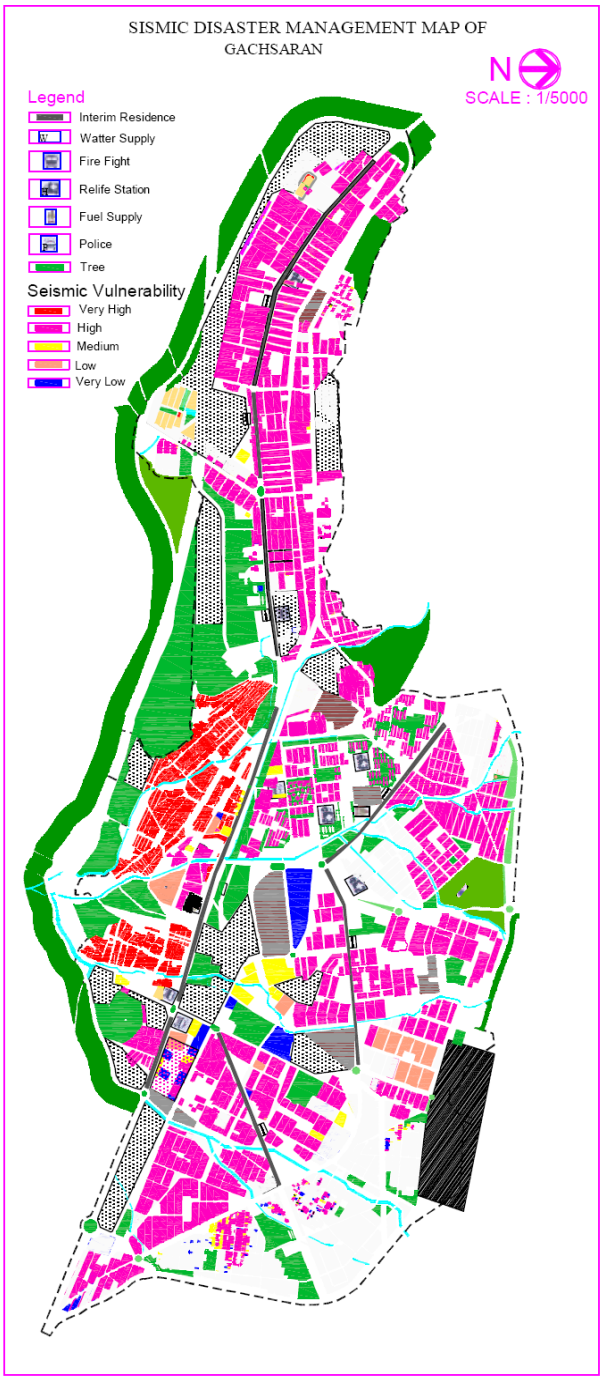

Figure 10. Proposed disaster management planning map for city of gachsaran.

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