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Rapid Assessment of Seismic Vulnerability in Palestinian Refugee Camps

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Abstract: Studies of historical and recorded earthquakes in Palestine demonstrate that damaging earthquakes are occurring frequently along the Dead Sea Transform: Earthquake of 11 July 1927 (ML 6.2), Earthquake of 11 February 2004 (ML 5.2). In order to reduce seismic vulnerability of buildings, losses in lives, properties and infrastructures, an attempt was made to estimate the percentage of damage degrees and losses at selected refugee camps: Al Ama'ri, Balata and Dhaishe. Assessing the vulnerability classes of building structures was carried out according to the European Macro-Seismic Scale 1998 (EMS-98) and the Federal Emergency Management Agency (FEMA). The rapid assessment results showed that very heavy structural and non structural damages will occur in the common buildings of the investigated Refugee Camps (many buildings will suffer from damages grades 4 and 5). Bad quality of buildings in terms of design and construction, lack of uniformity, absence of spaces between the building and the limited width of roads will definitely increase the seismic vulnerability under the influence of moderate-strong (M 6-7) earthquakes in the future.

Key words: Seismic vulnerability, buildings, life lines, refugee camps, Palestine

INTRODUCTION

The world is experiencing long-term changes such as sea level rise, reduction in water supply and quality and bigger, more frequent natural disasters. In the face of these inherent threats, the world's populations and governments are challenged to plan for the future to create safer, more sustainable cities and to protect our natural environment. Planning in any field of human endeavor involves both visionary and systematic thinking about the future with a focus on desired outcomes, how to achieve them and with what resources. Planning is dynamic, not static, involving a learning cycle in which results of plan implementation actions help in revising, clarifying, or amplifying the same or subsequent plans. These generic concepts are present in all planning, including for city development and environmental improvement.

Earthquakes pose a dilemma for policy makers, scientists and engineers. Decisions-making is complicated and challenging because earthquakes are unpredictable, they strike without warning, forecast of their physical effect are ambiguous and their large sudden loss potential threatens the economic stability of the nation (UNESCO, 1995; EERI, 2000, 2001, 2003). In Palestine, the earthquake and hazards happens frequently, so the disaster countermeasures are very important, where many cities had damages by the disaster during the past hundred years (Al-Dabbeek and El-Kelani, 2004).

Seismicity in Palestine is largely affected and controlled by the geodynamic processes acting along the Dead Sea Transform- DST (Quennell, 1959, 1983; Fruend *et al*., 1968; Ginzburg *et al*., 1981; Garfunkel, 1981; El-Isa, 1985; El-Isa and Mustafa, 1986; El-Isa, 1992; El-Isa *et al*., 1987; Haberland *et al*., 2003; Hassouneh, 2003; Weber *et al*., 2004; El-Kelani, 2006). The DST is a left-lateral fault between the Arabia and the Sinai tectonic plates that transfers the opening at the Red Sea to the Taurus-Zagrous collision zone (Fig. 1). The left-lateral shear along the Dead Sea transform since the middle Miocene explains the systematic ~105 km offset of numerous pr-Miocene geologic features (Quennell, 1959; Fruend *et al*., 1968). It is also consistent with paleoseismic and archaeosismic observations revealed in the sedimentary and archaeological sections excavated along the DST (El-Isa and Mustafa, 1986). The estimated MMS intensities of historical earthquakes in the Dead Sea region reach up to X, where the determinable magnitudes of the recorded earthquakes range between 1.0 and 6.5, on the local magnitude scale, ML (Shapira, 1988, 1983; Abou Karaki, 1987; Shapira and Feldman, 1987; Ambraseys *et al*., 1994).

Recent earthquake scenarios vulnerability of buildings for the main Palestinian cities (Jerusalem,

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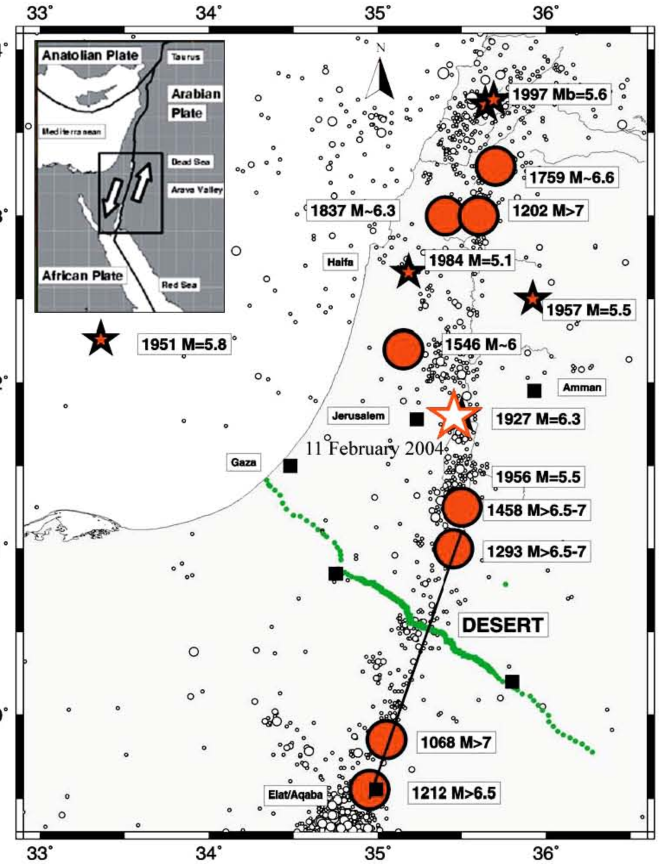

Fig. 1: Seismicity map of the Dead Sea Transform region (Abou Karaki, 1987; Shapira, 1988; Ambraseys *et al*., 1994) for the period 1000-2007. Also shown is the DESERT deep seismic sounding line (El-Kelani *et al*., 1998; Haberland *et al*., 2003; Hassouneh, 2003; Ruepker *et al*., 2003; Weber *et al*., 2004; El-Kelani, 2006)

Hebron, Ramallah, Nablus, Jenin, Tulkarem and Jericho) have been conducted by the Earth Sciences and Seismic Engineering Center (ESSEC) at An-Najah University (Al-Dabbeek, 2007). The results showed that one third of the investigated buildings belong to seismic vulnerability of class A (many buildings will suffer heavy damage); whereas about 40% of the buildings indicate class B (many buildings will suffer moderate damage). Despite the high predicted vulnerability of buildings in Palestine, the possibility of related disasters may have disappeared from the mind of people and anti-seismic design principles in civil engineering are not always properly considered, knowledge of the further earthquake potential of a region is essential to, e.g., planners, decision makers, civil engineers and insurance industry.

Based on seismic hazard maps of various levels of excellence probabilities (Al-Tarazi, 1999, 1994) measures of earthquake resistance should be taken for different kind of structures having different risk potential. On the other hand, seismic vulnerability studies, site effect and damage estimation are essential to assess the risk level of certain earthquake scenarios (Al-Dabbeek and El-Kelani, 2004, 2005; El-Kelani and Al-Dabbeek, 2005). The regions in Palestine suffer in general and the refugee camps in particular, from planning absence, random urban expansion and multiple land use, with lack of seismic information (e.g., geology, soil classification, site effect measurements, intensity maps) and insufficiency of master plans that refers to several consideration such as land slides, faults and plans that determines the hypoactive seismic areas. An attempt was made in this study to investigate the seismic vulnerability of buildings in Palestinian refugee camps: Al Ama'ri, Balata and Dhaishe as case study in West Bank (Fig. 1).

The problems relating to earthquakes in most of Palestinian refugee camps can be summarized, but not limited, to the following:

- High vulnerability to earthquake damages and losses, as a direct result of high percentage of weak buildings that do not comply with seismic resistant requirements.

This situation was created by the following major factors:

  - Bad construction practices and common fatal design mistakes of the buildings (soft storey, short column, lack of verticality and continuity of vertical structural elements, i.e. very high eccentricity and bad quality of material and workmanship....).
  - Lack of a national code for seismic design and construction;
  - Absence of national legislative laws and regulations for protection against earthquakes and multiple land use, with lack of seismic information (e.g., geology, soil classification, site effect measurements, intensity maps) and insufficiency of master plans that refers to several consideration such as land slides, faults and plans that determines the hypoactive seismic areas.
  - Absence of effective mechanisms for control of application (design and construction) and enforcement of regulations.

- Weakness of national programs and public policies on preparedness, mitigation and emergency response.
- Weak institutional capacity in disaster management and rescue operations.
- Weakness of awareness by citizens and weak capacity of professionals, engineers and decision makers.

Within the context of International strategy for Disaster Reduction ISDR (Untied Nations, 2004, 2006) strategies for achieving the millennium goals and described in the road map leading to the implementation of the united Nations Millennium Declaration (A/56/326) include:

- Developing early warning systems, vulnerability mapping, technological transfer and training.
- Supporting interdisciplinary and intersectoral partnerships, improved scientific research on the causes of natural disaster and better international cooperation.
- Encouraging governments to incorporate disaster risk reduction into national planning processes, including building codes.

MATERIALS AND METHODS

To reduce vulnerabilities and losses in lives, properties and infrastructures, seismic vulnerability of buildings and infrastructures, an expected percentage of damage degrees and losses in selected Refugee Camps in West Bank will be investigated (Fig. 2). In addition, location and distribution of the main elements of the camp risk map will be produced. Thus, there is a need to develop a data bank regarding the vulnerability of buildings and infrastructures in Palestinian refugee camps that will include:

- Determining the factors affecting the seismic vulnerability.
- Assessing the vulnerability classes (Rapid assessment) based on by taking into consideration the building structural systems and other factors like site conditions, architectural and structural configurations, adjacency, earthquake resistant design and the importance of building, for more details about vulnerability classes according to EMS-98.

On the other hand, the institutional capacity for risk mitigation, disaster management and emergency response will be provided by:

- Distribution of main roads, essential buildings and others infrastructures buildings on the risk map.
- Earthquake scenarios for the investigated Refugee Camps.

It is hard to find two identical buildings. In order to be able to derive information of prognostic value from the inspection of earthquake damage, buildings must; therefore, be classified into a limited number of structural types. The definition of each type must not be only narrow enough to ensure some degree of uniformity in seismic response of all buildings within the type, but wide enough to ensure that the number of buildings in each type is large enough for statistical analysis. Therefore, it is necessary to define the relation between building types (in addition to the architectural and structural building configurations) and vulnerability classes, as well as between vulnerability classes and damage grades. The studies of vulnerability of buildings in the selected refugee camps were done according to the European Macroseismic Scale (1998) and the Fedral Emergency Management Agency (FEMA).

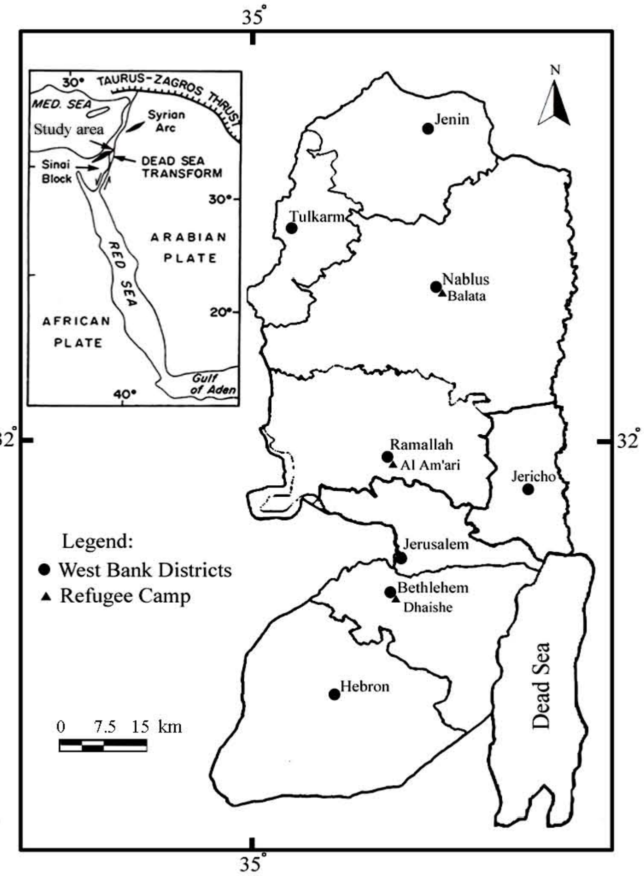

Fig. 2: Location map of the refugee camps; Balata, Al-Ma'ri and Dhaishe, distributed in the Palestinian districts

Building types: Generally the buildings in the West Bank-Palestine are divided into different types according to the construction system:

- Stone masonry
- Brick masonry
- Reinforced concrete beam-columnslab system (Joist System)
- Reinforced concrete braced (in-filled) frame structures
- Reinforced concrete shears wall structures
- Bearing wall structures

As for the refugee camps, most of the buildings can't be categorized into specific construction systems because of the pr-mentioned deficiencies. The construction practice or system can't be considered as frame or braced frame or even bearing wall. It is more or less a brick wall with columns and beams mostly designed to work separated and to resist vertical loads only.

Factors affecting the seismic vulnerability of buildings: There are different factors affecting the overall vulnerability of a structure besides its construction type. These factors are generally applicable to all types of structures.

According to the site and building investigations, the following factors have been considered:

- Site conditions.
- Regularity and configuration of structural and architectural elements.
- **Position:** Severe damage can occur to two adjacent buildings if they do not have enough spacing (seismic joint).
- Strengthening
- Earthquake resistant design (ERD).
- **Importance:** The importance of a building is determined by the number of occupants or visitors, the use of buildings or the danger for public and environment in case of building failure.

Assigning vulnerability classes and expected damage grades: Assessing the vulnerability classes of building structures was done according to the EMS-98. For Reinforced Concrete (RC) frame buildings without earthquake resistant design ERD, vulnerability classes B to C are probable with C being most likely. For RC frame buildings with serious defects (such as soft storeys, weak columns, lack of stiffening elements, long or very long cantilevers with heavy loads at the end…etc), vulnerability class B or even A maybe appropriate. For regular RC buildings without ERD, but incorporating a certain level of lateral resistance (due to wind load design or stability verification), vulnerability class D might be representative for exceptional cases. For RC wall structures without ERD, vulnerability classes C to D are probable with C being the most likely one. For RC walls with serious defects, vulnerability class B can be regarded as the exceptional case. One should notice that defects will not lead to such a drastic decrease of vulnerability which can be observed in case of RC frame structures.

To emphasize the necessary data required for assigning the vulnerability classes of buildings in Palestinian Refugee Camps, as a case study many buildings in the selected Refugee Camps were investigated by collecting data based on the following parameters:

- Site slope
- Soil type
- No. of storeys
- Slenderness ratio
- Quality of Material and State of concrete
- Construction over an existing old building
- Buildings within the vicinity
- Building type and Structural system
- Existence of cantilever structural system
- Soft storey
- Symmetry of stiffness in horizontal plan
- Horizontal and vertical stiffness Variations
- Staircase structural system and location
- Building entrances and exists
- Symmetry in horizontal configuration
- Symmetry in vertical configuration
- Horizontal symmetry in masses
- Formation of short columns
- Fastening and detailing between structural and nonstructural elements

The results of the pre-mentioned investigations (Rapid Assessment) were arranged in standard tables for all investigated buildings (Table 1, 2); also representative photos for few selected Buildings are shown in Fig. 3.

The rapid assessment/ evaluation process is a statistical method for determining the seismic resistance of a group of structures and it is based on: Visual observation of external changes of building and its structural system (no need to enter the building), in some cases general information from structural plans were used. Generally the results obtained from this method represent important indicator for engineers decisions concerning and entire group of structures (not for individual structures).

According to the survey of the investigated buildings in the selected Camps, the results showed that the major seismic deficiencies in configuration and structural systems are distributed, but not limited to, as follows (Table 3).

Based on expected earthquake intensities (MM~ 8-9 probable range ~ EMS intensities) and taking into consideration the seismic vulnerability of the common buildings in AL Ama'ri refugee camp, very heavy structural and non structural damages will occur (Many

Table 1: Seismic vulnerability of selected buildings- AL Am'ri refugee camp

No.	Category code	Building type	ERD and seismic details	Slope -site	Soil type	Building Mat. conditions	Slenderness ratio	Plan unsymmetry	Elevation unsymmetry	Position (seismic joints)	Soft story	Short columns	Cantilever systems	Main entrance	DBSNS	Seismic Vulnerability A	B	C	D
16-Am	N/A	RC -Mas	Without	...	S_c	G	<3	L	M	.....	L	L	L - M	Unsafe	G		●		
17-Am	N/A	RC - Brick	Without	...	S_c	G	<3	....	L	....	.....	L	.....	Safe	G			●	
18-Am	N/A	RC - Brick	Without	....	S_c	B	<3	....	L	Need	M	L	.....	Safe	B		●		
19-Am	N/A	RC - Brick	Without	....	S_c	VB	<3	L	L	Need	M	M	.....	Unsafe	....	●			
20-Am	N/A	RC - Brick	Without	....	S_c	VB	<3	L	M	.....	H	M	L	Unsafe	....	●			
21-Am	N/A	RC - Brick	Without	....	S_c	B	<3	L	H	.....	M	M	L	Unsafe	VB	●			
22-Am	N/A	RC - Brick	Without	....	S_c	B	<3	M	H	Need	H	L	L	Unsafe	B	●			
23-Am	N/A	RC - Brick	Without	....	S_c	B	<3	M	M	Need	L	L	.....	Safe	B		●		
24-Am	N/A	RC - Brick	Without	....	S_c	G	<3	M	L	……	.....	L	.....	Safe	G			●	
25-Am	N/A	RC - Brick	Without	....	S_c	G	<3	....	M	……	.....	.....	.....	Unsafe	....		●		
26-Am	N/A	RC - Brick	Without	....	S_c	G	<3	L	H	……	M	H	M	Unsafe	....	●			
27-Am	N/A	RC - Brick	Without	....	S_c	B	5	L	H	……	M	L	.....	Unsafe	....	●			
28-Am	N/A	RC - Brick	Without	....	S_c	VB	<3	L	H	Need	H	M	.....	Unsafe	....	●			
29-Am	N/A	RC - Brick	Without	....	S_c	B	<3	...	M	Need	L	L	L	Unsafe	....		●		
30-Am	N/A	RC - Brick	Without	....	S_c	B	<3	....	L	……	L	L	L	Unsafe	....		●		

L: Low, E: Excellent, I: 1, Normal, Residential Buildings. S_A: Hard Rock, M: Moderate, VG: Very Good, I: 1.2, Hazardous Buildings, Schools, Hospitals. S_B: Rock. H: High, G: Good, S_C: Very dense soil and soft rock. W_L: Low weight, B: Bad, I = 1.5, Essential Buildings, Power- Generating stations,All structures with occupancy grater than 500 Persons. S_D: Stiff soil profile. W_M: Moderate weight, VB: Very Bad, S_E: Soft soil profile. W_H Heavy weight, N/A:Not Available, S_F Soil requiring site-specific evaluation. ERD: Earthquake Resistance Design, (-): Not applied or no effect for the mentioned factor. DBSNS: Details between structural and nonstructural elements, RC-Brick:Renforced Concrete Brick, RC-Mas: Reinforced Concrete Massenory

Table 2: Seismic vulnerability of selected buildings- Balata refugee camp

No.	Category code	Building type	ERD and seismic details	Slope -site	Soil type	Building Mat. conditions	Slenderness ratio	Plan unsymmetry	Elevation unsymmetry	Position (seismic joints)	Soft story	Short columns	Cantilever systems	Main Entrance	DBSNS	Seismic Vulnerability A	B	C	D
46-B	N/A	RC - Brick	Without	L	S_c	G	<3	....	L	.....	L	L	......	Unsafe	B		●		
47-B	N/A	RC - Brick	Without	L	S_c	B	<3	....	L	Need	L	M	L -W_M	Unsafe	B		●		
48-B	N/A	RC - Brick	Without	L	S_c	B	<3	L	M	.....	M	M	L -W_L	Safe	VB	●			
49-B	N/A	RC - Brick	Without	L	S_c	VG	<3	L	L	.....	.....	L	....	Safe	B			●	
50-B	N/A	RC - Brick	Without	L	S_c	G	5	L	M	Need	H	H	......	Safe	B	●			
51-B	N/A	RC - Brick	Without	L	S_c	G	<3	L	M	Need	L	M	L -W_L	Unsafe	B		●		
52-B	N/A	RC - Brick	Without	M	S_c	G	<3	M	H	.....	M	M	H -W_M	Unsafe	VB	●			
53-B	N/A	RC - Mas	Without	M	S_D	B	4	L	M	......	H	M	....	Unsafe	VB	●			
54-B	N/A	RC - Brick	Without	L	S_c	B	<3	L	L	Need	L	M	M -W_L	Unsafe	G		●		
55-B	N/A	RC - Brick	Without	....	S_D	VG	<3	L	M	......	H	H	....	Safe	B	●			
56-B	N/A	RC - Brick	Without	....	S_D	G	<3	M	L	Need	L	M	L -W_L	Unsafe	VB		●		
57-B	N/A	RC - Brick	Without	....	S_D	G	<3	L	M	......	L	L	....	Safe	B		●		
58-B	N/A	RC - Brick	Without	....	S_D	G	5	L	H	Need	M	M	....	Safe	B	●			
59-B	N/A	RC - Brick	Without	....	S_D	VB	<3	....	L	Need	H	M	L -W_L	Safe	VB	●			
60-B	N/A	RC - Brick	Without	....	S_D	B	<3	...	L	Need	H	L	M -W_M	Unsafe	B	●			

L: Low, E: Excellent, I= 1, Normal, Residential Buildings. S_A: Hard Rock. M: Moderate, VG: Very Good, I=1.2, Hazardous Buildings, Schools, Hospitals. S_B: Rock. H: High, G: Good, S_C: Very dense soil and soft rock. W_L: Low weight, B: Bad, I= 1.5, Essential Buildings, Power-Generating stations, All structures with occupancy grater than 500 Persons. S_D: Stiff soil profile. W_M: Moderate weight, VB: Very Bad, S_E: Soft soil profile. W_H: Heavy weight, N/A:Not Available, S_F: Soil requiring site-specific evaluation. ERD: Earthquake Resistance Design, (-): Not applied or no effect for the mentioned factor. DBSNS : details between structural and nonstructural elements, RC-Brick:Renforced Concrete Brick, RC-Mas: Reinforced Concrete Massenory

Table 3: Distribution of main seismic deficiencies: for more details about the seismic deficiencies see Fig. 3

Seismic deficiencies	Balata (%)	AlAm'ari (%)	Dhaisha (%)
Soft and weak storey/stories	34	33	39
Existence of cantilever structural systems	13	15-20	22
Lack of seismic joints (for adjacent buildings and where necessary)	82	75-80	73
Buildings within the vicinity	63	60	-
Slenderness ratio: (H/B) >4			
(with lack of symmetry in vertical and horizontal configurations)	12	10	9
Relation between columns and brick walls - inadequate fastening between structural and nonstructural elements.	70	55	71
Lack (Bad) of continuity and verticality of vertical structural elements.	62	40-50	56
Walls (Bearing Masonry Walls) without columns	32	20	28
Lack of spaces between buildings	92	90	83
Inadequate building entrances and exists	56	60-70	60

buildings will suffer from damages of grades 4 and 5). Damages are expected under the influence of moderate-strong (M 6-7) earthquakes in the future. The classification of damage grades for reinforced concrete buildings according to European Macro seismic scale (EMS-98).

Risk maps and distribution of damages: The high vulnerability of the buildings and the infrastructures in the Palestinian refugee camps as figured out in this study will cause partial and total collapse in many of the buildings and other structures in these camps. It is also expected that it will be in all parts of the camp. The rapid evaluation conducted on buildings in selected areas (six in Al Amari, five in Balata and three in Dhaishe within the camp showed that the mistakes or reasons (deficiencies) which increased the vulnerability are the same in all parts of the camp (Fig. 3). Taking into consideration the nature and seismic vulnerability of the buildings and their distribution on the site plan of the camp/camps, it's expected to have the following scenario in case the area is subjected to a moderate to strong earthquake (6-7 M) with the epicenter in or near the Dead Sea area:

- The total areas of the roads, squares and spaces between the buildings don't exceed 3-5% of the total camp/camps areas.
- Absence of spaces between the building and the limited width of roads will increase the risk level and close most of the roads. Consequently the many residential areas within the camp will be isolated (see the selected maps of the camp presented in Fig. 4a, b.
- There are areas or lands near the camp that could be used for emergency response activities and for temporary shelter (Fig. 4b).
- Many public buildings have high vulnerability and it is expected to collapse under the expected earthquake in Palestine.
- Lack of application of safety measures and using the gas networks inside the houses by the camp inhabitants will increase the number of death and casualties.
- The areas of Al-Am'ri and Dhaishe refugee camps are small compared to other camps, in addition to the spaces surrounding it can be benefited from in preparing the plans and scenarios for opening the closed roads and new roads as well which will contribute a lot in the emergency evacuation of people.

The earthquakes do not affect only the buildings, but also have very bad impact on the lifeline systems including water, waste water and communications. The major concern in the refugee camps is related to the water

Main roads

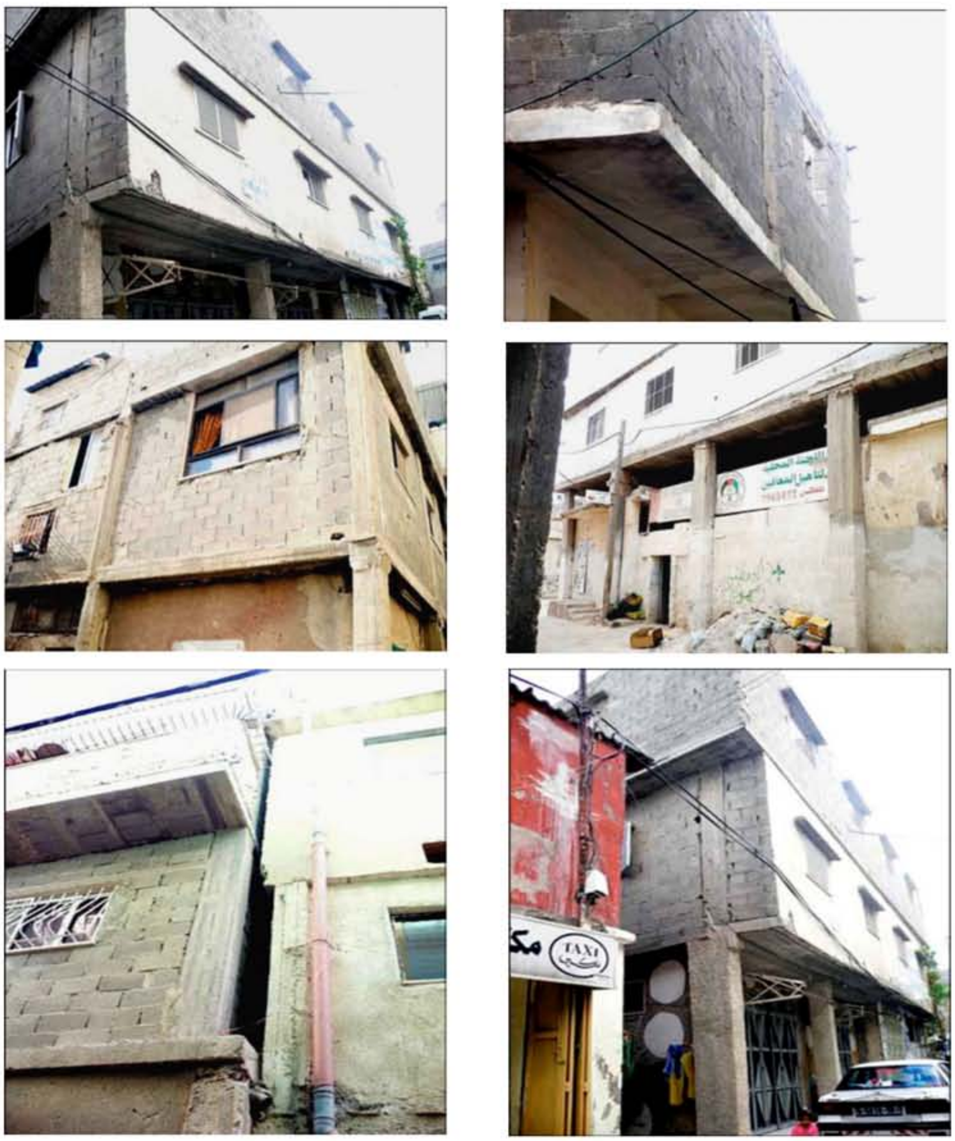

Fig. 3: Continued

Fig. 3: Selected photos from the Palestinian Refugee Camps: Al Ama'ri, Balata, Dhaishe

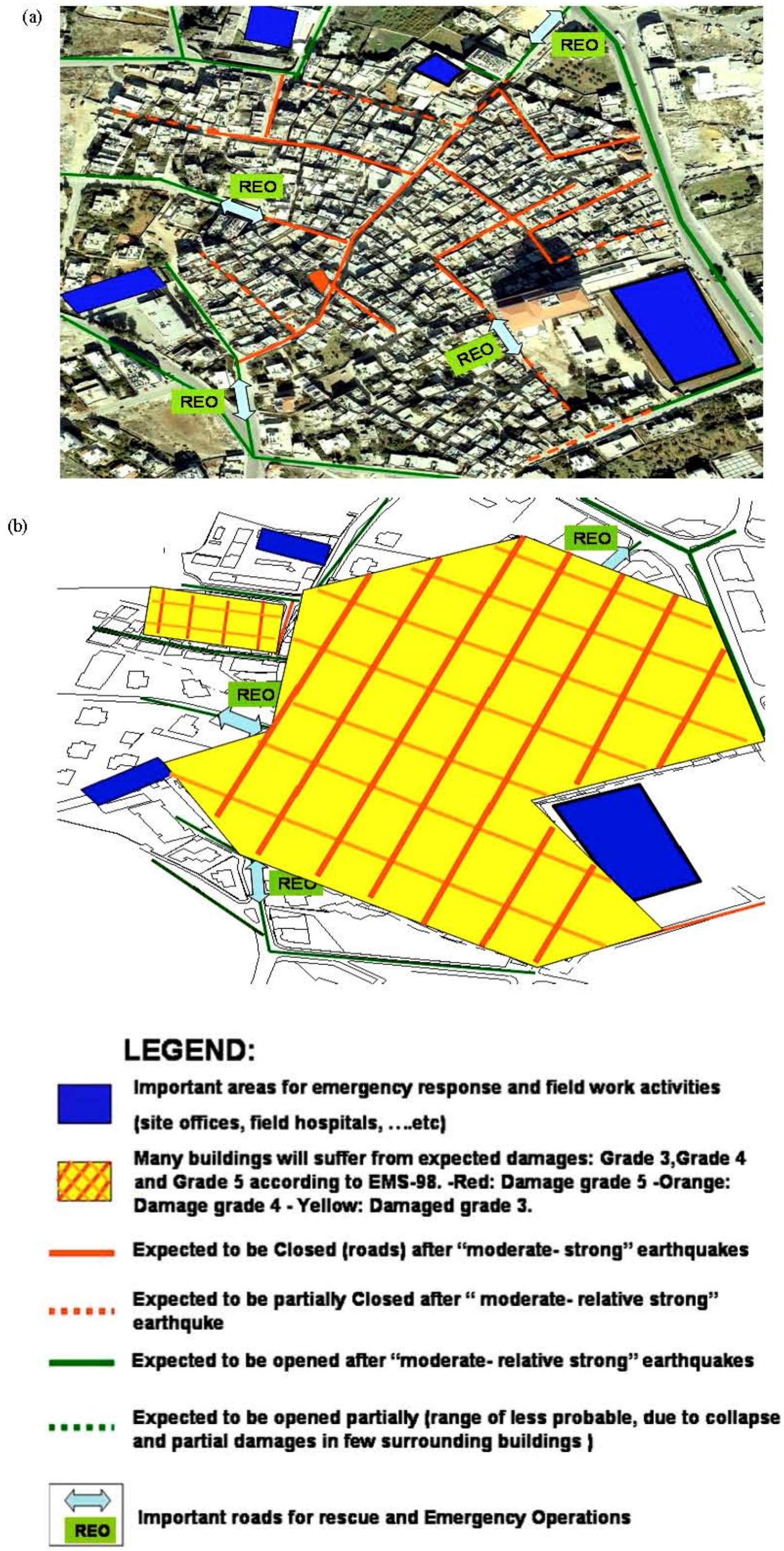

Fig. 4: Risk maps and earthquake senarios

and wastewater networks which do not cover the minimum standards of life without being subjected to damage.

It is expected, when subjected to moderate-strong earthquake to have major damage to the water and waste water networks causing pollution and contamination to water supply caused by waste from homes and factories, if any.

The effect can be summarized as follows:

- Reliable drinking water will not be available
- Bad effect on people's health causing diseases
- Also bad effect on the environment
- Contamination of soil and ground water

It does also worth to mention that, the cesspools and septic tanks are very familiar in the refugee camps. They will be damaged causing more bad effect to the water, soil and environment.

As a result of the above deficiencies, the seismic performance is poor and the vulnerability of the buildings and infrastructure will increase drastically.

CONCLUSIONS

A significant part of development assistance is spent on the construction of infrastructure in developing countries. However, these investments and associated development gains can be lost in seconds in the event of a natural hazard event (Charlotte and John, 2007). The majority of human and direct economic losses from a natural hazard event occur as a direct result of damage to the built environment and/or ineffective early warning and evacuation systems. The negative impact of natural hazards on communities can be limited by taking such hazards into consideration when selecting sites, designing new infrastructure strengthening existing infrastructure.

Based on the Hyogo framework for action (Untied Nations, 2006), governments as well as regional, international and non-governmental organizations should be committed to the following action priorities:

- Ensure that disaster risk reduction is a national and local priority.
- Identify, assess and monitor disaster risks and enhance early warning.
- Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
- Strengthen disaster preparedness for effective response at all levels.

An effort was made in this study to follow up the international considerations (Tucker *et al.*, 1994; EERI, 1996; Cardona *et al.*, 2000; Villacis and Cardona, 2000) in assessing the seismic vulnerability of buildings where the following main remarks were concluded:

- Most the buildings included in the investigations were relatively new.
- Bad quality of buildings in terms of design and construction, Lack of uniformity and absence of seismic design regulations will increase the vulnerability of the buildings and infrastructure when subjected to earthquakes.
- Absence of spaces between the buildings and the limited width of roads will increase the risk level and close most of the roads. Consequently the many residential areas within the camps will be isolated.
- Lack of awareness between the people to the safety measures and regulations in addition to the lack of discipline prevailing in the streets due to the very bad political situation, will cause panic and mess to a level that will affect all emergency, saving and first aid activities.
- Absence of an effective disaster management process and Palestinian institutions for support against disasters will contribute a lot in increasing the level of risk.
- Considering the structural situation of the buildings and the infrastructure in the selected camps and based on the general investigation of the refugee camps in the West Bank, it is expected to have failures and heavy damages to buildings and infrastructure in all refugee camps if subjected to a moderate to relatively strong earthquake ($M = 6$ to 6.5).

It should be noted that most of the refugee camps in Palestine particularly in West Bank are similar in the level of risk and vulnerability of the buildings and infrastructure to damage when subjected to earthquakes. Thus, the results and scenarios expected on the investigated camps can be applied to a high extent on other refugee camps in West Bank. In order to reduce the level of damage and the loss of lives and property and based on the intentional strategy for disaster reduction (United Nations, 2004; Maxx, 2005; Charlotte and John, 2007), there is a vital need to take measures to reduce the seismic vulnerability of buildings and infrastructures in refugee camps. Based on the importance of seismic upgrading of the existing vulnerable buildings and infrastructure and taking into consideration the limitation of the funds, it's recommended to implement the required upgrading plan, through using the priority steps concepts:

First priority: The first priority should be accorded for the public buildings and for the seismic vulnerable buildings situated around the main road.

Second priority: The second priority should be accorded for the seismic vulnerable buildings situated around the secondary roads.

Third priority: The third priority should be accorded for the other seismic vulnerable buildings.

In addition to that, there is a need to develop the public awareness and the capacity building for people and institutions of support and management against disasters as well.

Also as a second step it is recommended to investigate the vulnerability and seismic performance of buildings and infrastructures in Gaza Strip.

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