بسم الله الرحمن الرحيم

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Urban Planning & Disaster
Risk Reduction Center

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مركز التخطيط الحضري
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Assessment of Seismic Site Effect

(GEOPHYSICAL SEISMIC STUDY)

Palace of Justice

(Al-Baloa /Al-Bireh).

Final Report

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1. INTRODUCTION

1.1 Background

The site of Palace of Justice is located in Ramallah & AL-Bireh Governorate (see Figure 1.1). The Urban Planning and Disaster Risk Reduction Center UPDRRC (Earth Sciences and Seismic Engineering Units ESSEU) at An Najah National University was approached by Geotechnical and Material Testing center (GMT) seeking to conduct a Geophysical Seismic Study for the (Al-Baloa /Al-Bireh).

Figure 1.1: Geographic setting of the studied area in the West Bank

1.2 Problem Statement

Seismic information including historic and prehistoric data indicates that major destructive earthquakes have occurred along the Dead Sea Transform (DST). The DST is a left-lateral fault between the Arabia and the Sinai tectonic plates that stretches from the opening at the Red Sea to the Taurus-Zagrous collision zone. The estimated Moment Magnitude Scale (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 7 on the local magnitude scale. These damaging earthquakes caused, in several cases, severe destruction and many hundreds and sometimes thousands of fatal casualties.

Generally, local site effects (landslides, liquefaction, amplification and faulting systems) play an important role in the intensity of earthquakes. Thus, Earthquake-resistant design of new structures and evaluating the seismic vulnerability of existing buildings take into account their response to site ground motions. Geophysical studies of seismic activity in Palestine, deep seismic sounding, paleoseismic excavation, and instrumental earthquake studies of half a century demonstrate that damaging earthquakes occurred along the Dead Sea Transform fault. The topography, geomorphology and geology of the West Bank have been the main reasons behind several sizeable landslides that occurred around ten years ago in different parts of the West Bank. Also, it has been shown that Palestine suffered from several landslides during historical earthquakes.

Based on the seismic peak ground acceleration map (PGA Map) for the region (Figure 1.2), the studied area is located in zone 2B. The seismic zone factor (Z) on the rock for the zone 2B is equal to 0.2. According to the Uniform Building Code (UBC97), International Building Code (IBC), Jordanian Building Code 2005 and Arab Uniform Code 2006, it can be considered as moderate seismic area.

1.3 The scope of Assessment of Seismic Site Effect (ASSE)

The UPDRR at An Najah national University was approached by Geotechnical and Material Testing center (GMT) seeking to conduct a geophysical seismic study at the Palace of Justice - AL-Baloa/ Al-Bireh. This kind of studies provides engineering data and recommendation to mitigate the seismic site effect.

Based on the scope of services, field visit, data collection, data acquisition and data analysis, the geophysical seismic investigation under the contract should deliver a seismic report including the following tasks for the studied area:

1) Soil profiles.
2) Primary and shear wave velocities (V_p and V_s).

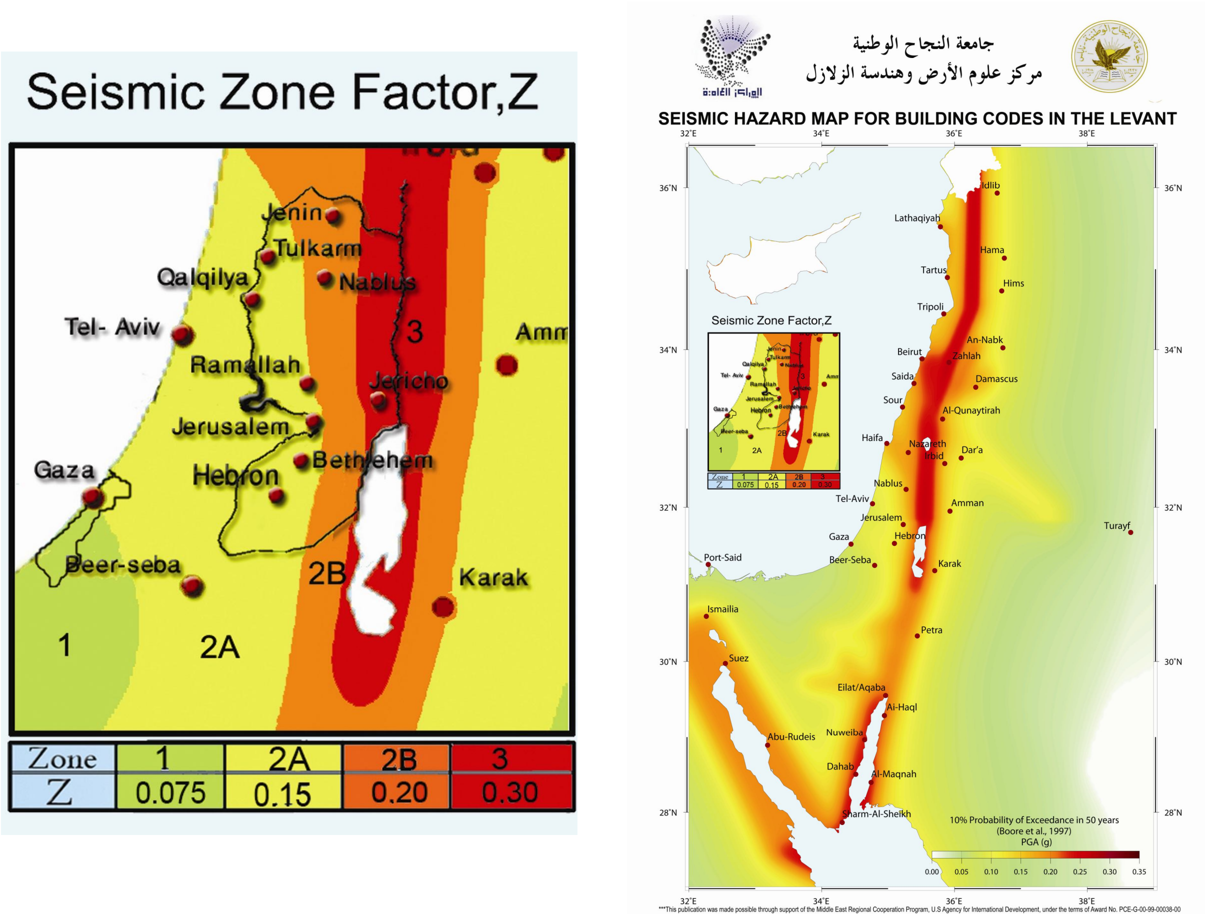

Figure 1.2: Seismic Hazard Map and Seismic Zone Factor (Source UPDRR)

2. GEOPHYSICAL SEISMIC STUDY: Site Investigations

2.1 Local Geology

Investigating the subsurface geology of a site is critical in order to select the kind of structure foundation design to use in a given area since sedimentary deposits are often the prime locations for the development of urban areas.

The exposed sequence of rocks in the studied area (Ramallah Group) mainly consists of limestone rock succession or dolomite or marl with rocks or chalk and limestone Cretaceous. Runs from the beginning of old age or Alsinomani Alpoti and even the end of the age Altopr. A representative of the limestone either pure limestone or with some continental mud in the case of Marle.

2.2 Methodology and Data Analysis

2.2.1 Geophysical experiment

The subsurface geology determined by seismic studies is extremely important for the development of highly populated, tectonically arid regions such as the Middle East. The shallow upper part (ten to hundred meters) of the rock formation section is the most significant part for civil infrastructures. The seismic refraction technique is considered an accurate geophysical method to investigate the shallow geological structures of an area. During the past decades, the seismic parameters obtained by a refraction survey have been widely used in cases of site investigation as indicators of rock mass quality. The main objective of the seismic refraction method is to estimate the first arrival velocities of P-waves, which are used to determine the depths of different layers and obtain the dynamic characteristics of rocks. These parameters are of great importance in land use management of various civil engineering purposes.

2.2.2 Detection of Seismic Waves

Seismic waves are generated usually by weight dropping, i.e. a sledge hammer. The seismic signals generated from the shot propagate in different direction; it is reflected, refracted, or diffracted. The different seismic signals can be recorded using a system of receivers (geophones) distributed in a profile in the direction of the shot point. In detecting direct and refracted waves a number of detectors are placed on the ground along a straight line passing through the shot point, this system is known as (In-line spread) and is widely used in most seismic refraction techniques.

For this study the system used was the Smart Seis Exploration seismograph model S/N 70253, manufactured by Geometric Europe (U.K). The detectors used in the present study have a natural frequency of 28 Hz each, the signal is amplified and the undesirable frequencies can be filtered out. These signals, after suitable amplification and filtering, are fed into a recording unit. The recording system contains 24 channels.

2.2.3 Data Acquisition and Analysis

The seismic refraction survey was conducted on 20 seismic lines (see Figure 2.1 for the location of the lines and the photos in Appendix no.1). The distance between the two receivers (geophone interval) was 5 meters. Many interpretation techniques are published in seismic refraction data analysis and each of them depends on the character of the refractor. In the present study, the seismic refraction data was interpreted using the modeling and interactive ray tracing techniques.

The travel time-distance curves and the corresponding ground models for P-waves were obtained. Depths of the interfaces were obtained from the travel time-distance curves for the P-waves. Table 2.1 summarizes the results obtained from the seismic lines for this study.

The P-waves were picked up as first arrivals. The underground model beneath the lines indicates two different layers beneath the seismic lines. The bed rocks beneath these lines from the two main layers, the first layer with thickness ranges between 2 to about 4 meters except for tour lines, Lines 15, 16, 17 and 18, where the thickness reaches about 4-5 meters. It is worth mentioning that the investigated site is not flat, and there are variations in the elevations up to 2 meters at some locations. (see appendix no. 2).

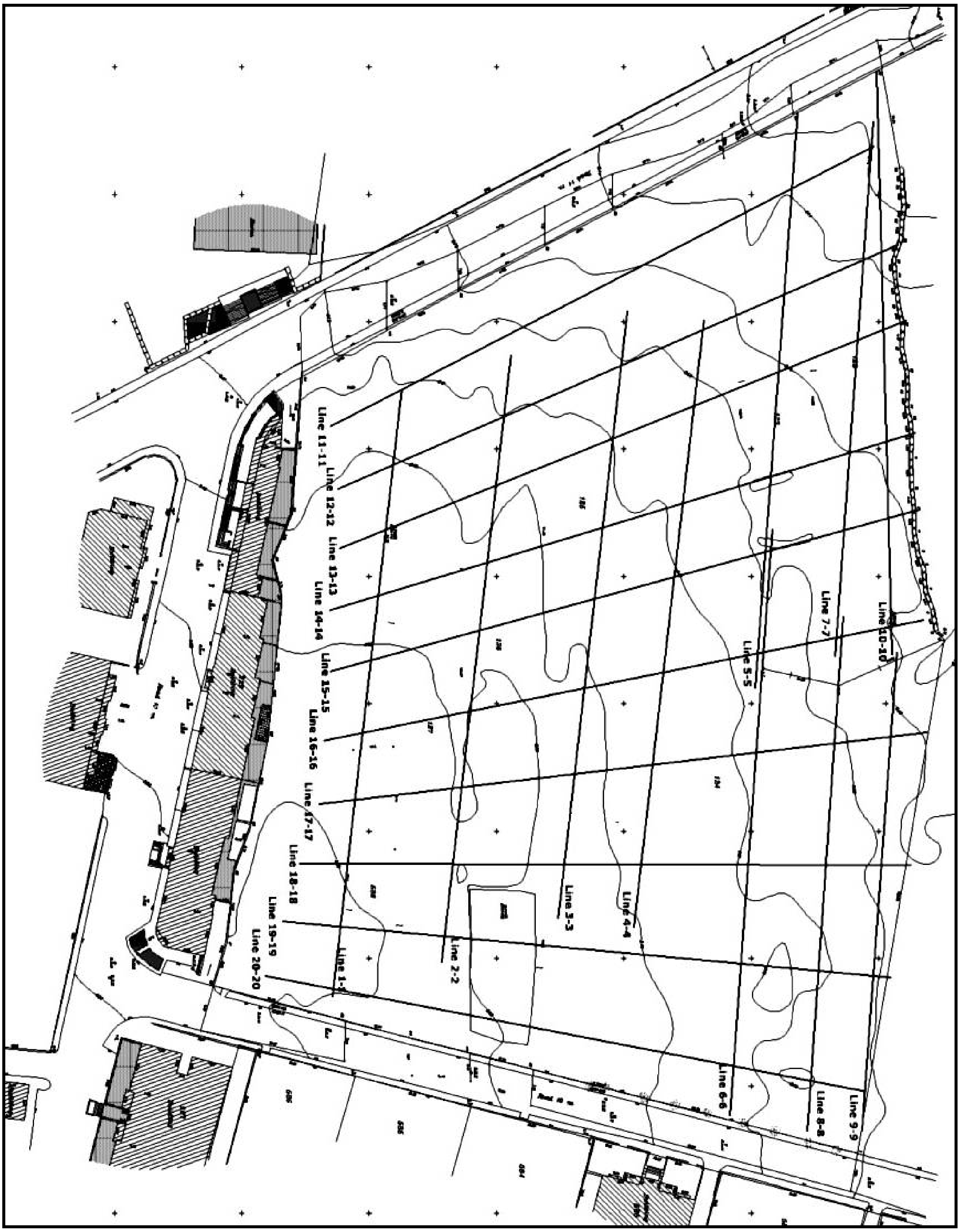

Figure (2-1): location of the seismic lines.

The travel time curves analysis showed longitudinal wave velocities (P waves) ranging from 150 to less than 500 m/s for the first layer except for Line 1-1 that shows about 958 m/s and about 2000 to 3000 m/s for the second layer beneath all seismic lines. The first layer is interpreted as weathered materials, where the second layer is interpreted as consolidated materials of limestone are the typical lithology of layer two for most of the seismic lines.

Table 2.1: Summary of results obtained from the seismic lines

Line Nr.	Layer 1		Layer 2	
	Vp m/sec	Thickness (m)	Vp m/s	Thickness (m)
Line 1-1	958	2-3	2901	∞
Line 2-2	357	3	2528	∞
Line 3-3	270	2-3	2610	∞
Line 4-4	192	2	2496	∞
Line 5-5	250	2-4	2445	∞
Line 6-6	152	2	1947	∞
Line 7-7	625	2-4	2463	∞
Line 8-8	289	2-3	3158	∞
Line 9-9	217	2	2339	∞
Line 10-10	257	2	3202	∞
Line 11-11	444	2-4	3269	∞
Line 12-12	390	2-4	2726	∞
Line 13-13	313	2-4	2719	∞
Line 14-14	152	2	2592	∞
Line 15-15	495	4-5	2501	∞
Line 16-16	385	2-6	2734	∞
Line 17-17	445	2-5	2139	∞
Line 18-18	378	3-5	2500	∞
Line 19-19	192	2	2183	∞
Line 20-20	156	2-3	1934	∞

Appendix no. 2: shows the travel time curves and the corresponding velocity ground models (geological cross sections for the two layers) beneath the 20 seismic lines.

4. Conclusions and Recommendations

Based on the outcropping geological cross-section in the study area and the ground velocity models deduced from the P-wave velocities of this study, the subsurface geological formations beneath the seismic lines are interpreted as soil cover of soft weathered material which forms the first layer beneath all seismic lines. The average thickness of the first layer for most of the investigated lines is about 2 to 4 meters and up to 5 meters at some locations that most probably due to the variation in the elevation. The second layer is explained as consolidated carbonate materials of limestone. The outcrops can be easily seen in some places on the surface.

The corresponding velocity ground models (geological cross sections for the two layers) beneath all the seismic lines show clearly an overlapping between layer one and layer two at different locations of the study area which means that there are lateral and vertical variations in the mineralogy and the geomorphology of the layer boundaries.

Based on the values of P-wave velocities and using the approximate values of the Poisson's Ratio (ν) for each layer (ν = 0.40 – 0.45 for clay and weathered materials and ν = 0.25 – 0.30 for marly and chalky limestone), the value of shear wave velocity (V_s) will be as follows:

- $\mathbf{V_s}$ = 60 m/sec and 220 m/sec for the first layer
- $\mathbf{V_s}$ = 1150 m/sec- 1500 m/sec for the second layer.

The values of shear wave velocities (V_s) at the proposed foundation levels will be around between 1100 m/sec and 1500 m/sec. Based on international and regional seismic design codes, such as: Uniform Building Code 97, International Building Code IBC, Jordanian Building Code 2005 (or 2008) and Arab Uniform Building Code 2006 the type of soil profile for the shear wave velocities mentioned above, will be S_E for the first layer and S_B for the second layer. In design it is recommended to use S_B for the buildings in studied area.

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