ANALYSIS OF STRONG GROUND MOTIONS RECORDED DURING THE 21 MAY 2003 BOUMERDES, ALGERIA, EARTHQUAKE

Nasser Laouami, Abdennasser Slimani, Youcef Bouhadad, Ali Nour and Said Larbes

CGS, National Center of Applied Research in Earthquake Engineering, 1 Rue Kaddour Rahim, Hussein Dey, B.P. 252, Algiers, Algeria.

Corresponding Author : N. Laouami, E-mail : n_laouami@hotmail.com

INTRODUCTION

The regions of Algiers and Boumerdes, North of Algeria, were shock by a destructive earthquake of magnitude M_w=6.8 (USGS) on Wednesday 21, May 2003 at 19:44:40 (GMT+1) which claimed about 2300 human lives and injured about 11000 peoples. It's therefore, the worst seismic event since the El Asnam October 10 1980, Ms=7.3.

The main shock caused widespread destructions mainly in the area of the Eastern part of Algiers, the capital, and Boumerdes, about 50 km NE of Algiers. The main shock was felt as far as 250 Km from the epicentre which was located offshore.

Many records were made by the national accelerograph network monitored by CGS. The maximum pick ground acceleration recorded at 20 Km to the epicenter reached 0.58 g. This earthquake induced liquefaction mainly along the Isser and Sebaou river valleys (figure 1), tsunamis in the Balearic islands, and site amplification mainly in the quaternary Mitidja basin, as well as uplift of the coastal line (figure 2). The main Shock was followed by several aftershocks among them those of May 27, 2003 (M_S=5.8) and May 28, 2003 (M_S=5.8) causing panic among the population which fled their homes, certain of the people live Algiers for other regions of Algeria. The May 27, 2003 injured about 100 people two of them throw him self from windows and killing 3 and destroyed the mostly affected constructions, particularly the R+10 building at Reghaia and the minaret of Zemmouri mosque.

Figure 1. Collapse of soil caused by liquefaction in the Isser valley region

Figure 2. Rocks raised after the main shock suggesting the uplift of the coast line (Boumerdes).

STRONG GROUND MOTION DATA ANALYSIS

In addition to the epicentral and surrounding areas, the earthquake was felt in a radius of more than 250 km where it was recorded accelerations about 0.02 g. The main shock was recorded by many stations of the national accelerograph network monitored by CGS. A temporal and frequentiel analysis were performed (Laouami et al., 2003).

Figure 3 show the map of the stations location with the pick ground accelerations recorded during the main shock in the E-W, N-S and Vertical directions.

The closest stations to the epicentre, in free field, which recorded the main shock are those of Keddara at 20 km. From figure 3, one can underline the following observations:

- At Keddara site, the maximum accelerations recorded by two stations distant from each other approximately 150 m are as follows:

Station 1: E-W: 0.34 g Ver: 0.25 g N-S: 0.26 g

Station 2 : E-W : 0.58 g Ver : 0.22 g N-S : 0.35 g

The very significant variation observed between stations 1 and 2 concerning more particularly accelerations in E-W direction suggest the presence of site effect particularly significant at station 2. A current geotechnical study will quantify this local site effects.

- PGA in E-W direction are more significant than those in the N-S direction.

This observation is valid almost at the majority of the stations, and is probably related to the directivity effect of the fault.

- Because located on the Mitidja quaternary basin classified as soft soils, The Dar El Beida and El Afroun stations records show high acceleration level compared to those located on firm soils.

Figures 4 and 5 show the E-W, N-S and Vertical accelerations recorded respectively at Keddara 1 and Meliana stations. The strong part duration given by the Husid diagram is about 10 s.

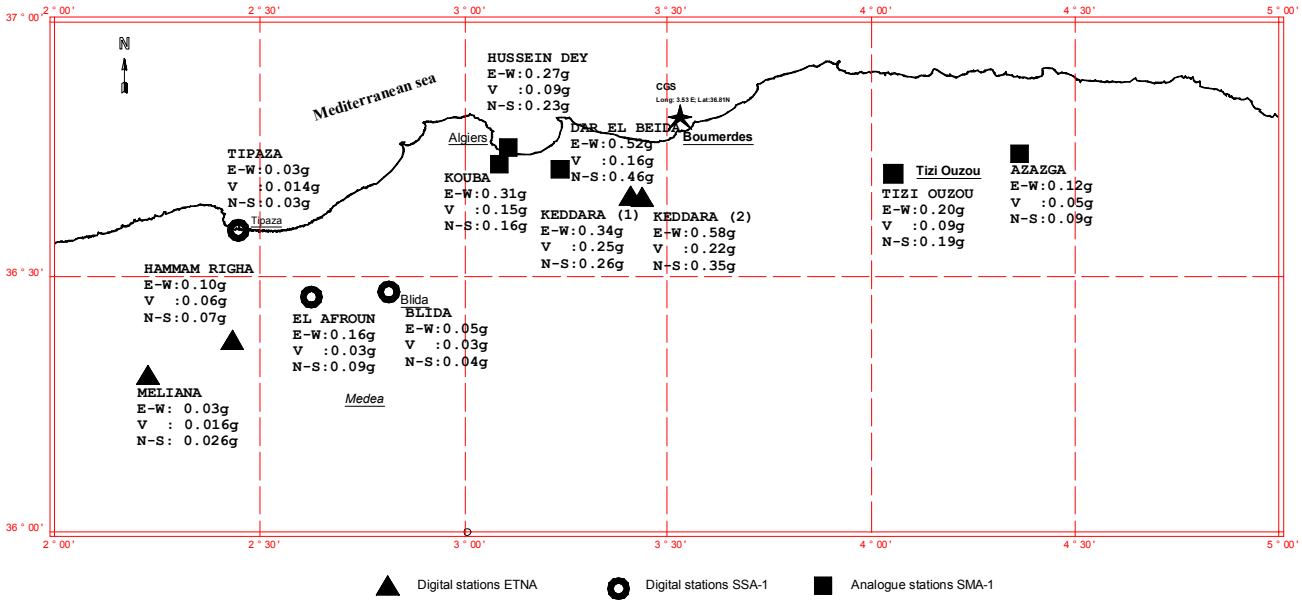
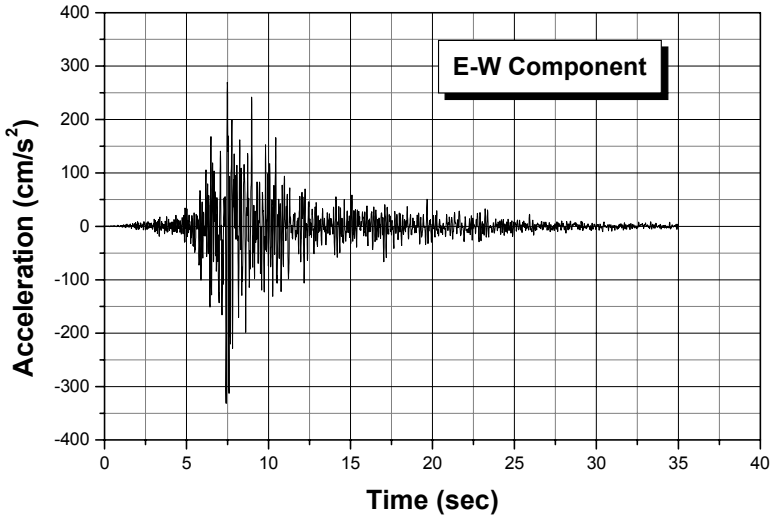
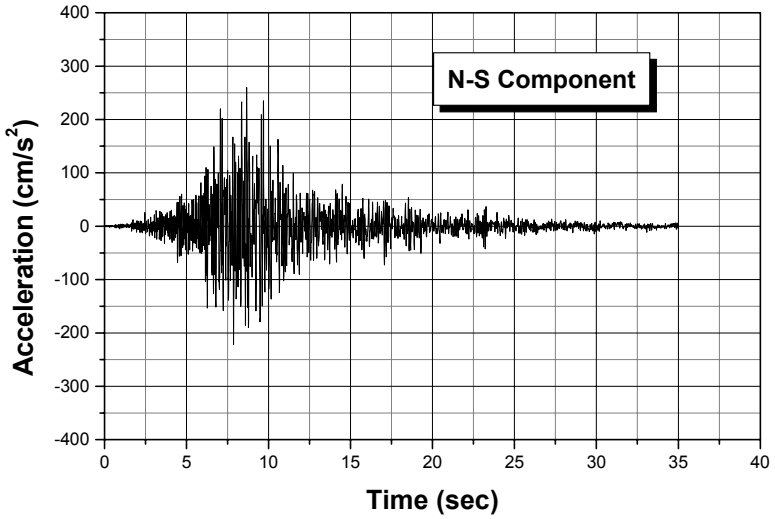


Figure 3 : Location of the recording stations and the corresponding recorded PGA in the E-W, N-S and Vertical directions. The star indicates the epicentre determined by CGS using accelerograms : Long: 3.53 E, Lat: 36.81 N.





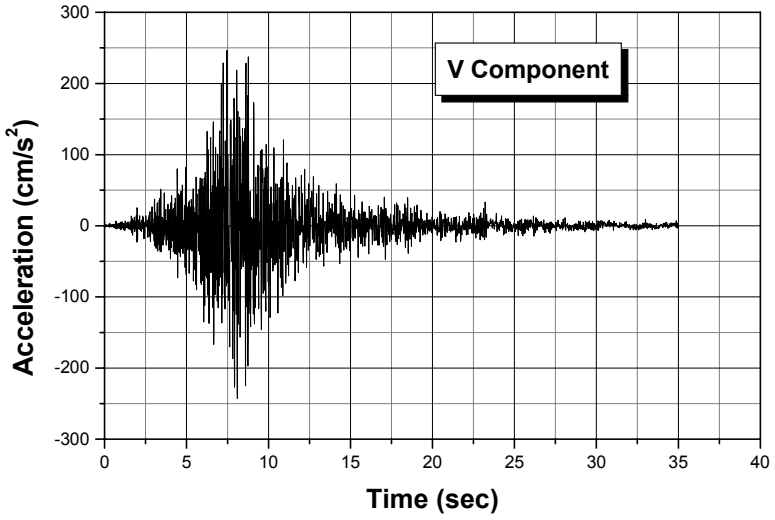
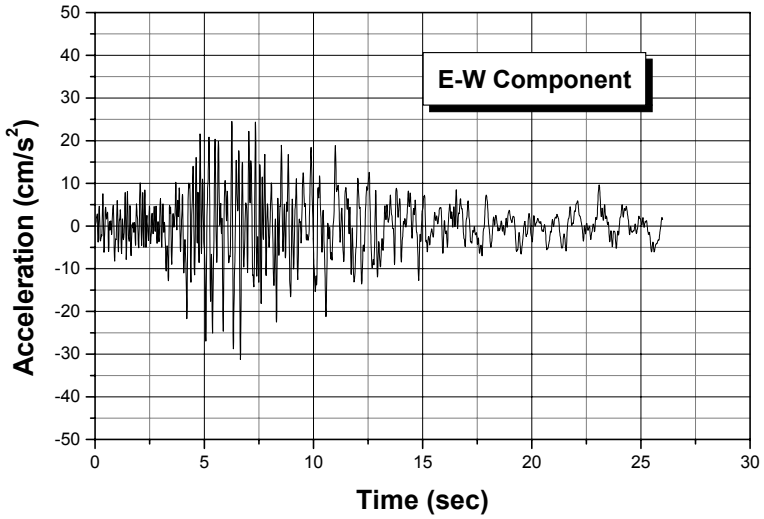
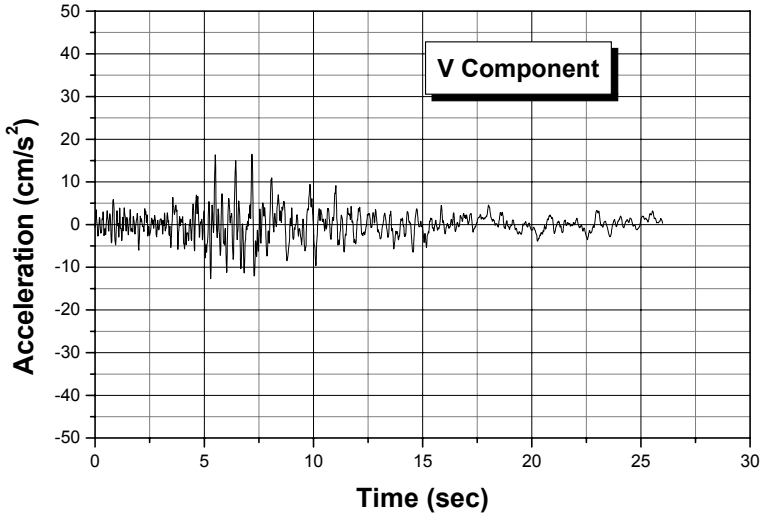


Figure 4 : E-W, N-S and Vertical accelerations recorded at Keddara 1 station.





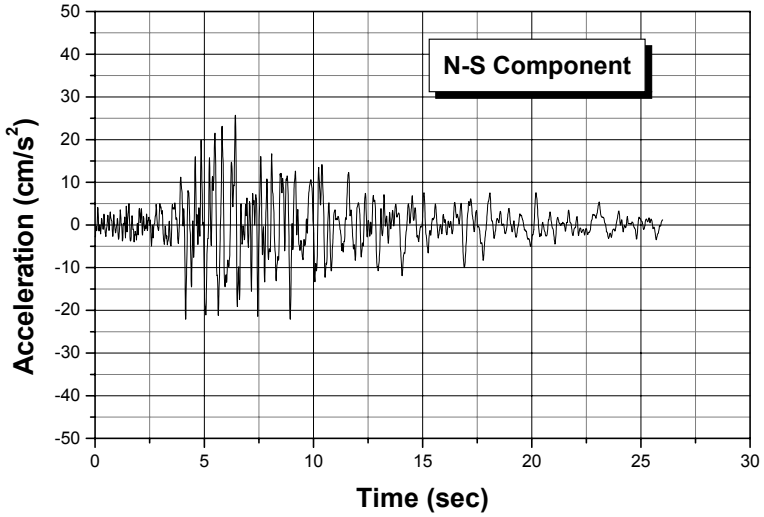


Figure 5 : E-W, N-S and Vertical accelerations recorded at Meliana station.

RESPONSE SPECTRA

The other parameter which characterizes the seismic movement is the frequency content. The study performed on the recordings obtained during the main shock may explains the observed damages in the epicentral region.

Figure 6 shows the response spectra of the E-W, NS and Vertical components for the station of Keddara1. The plotted curves show high frequency content for the Keddara station (near field). On the other hand, the most suffered buildings in the epicentral region have a fundamental frequency close to the earthquake frequencies.

ATTENUATION LAW

A comparative study is carried out between the recorded data during the main shock of the may 21 2003 Boumerdes earthquake with the attenuation law of Ambraseys (1995), developed on the basis of a sample of 1260 seismic records generated by 619 shallow earthquakes including Algerian data. Figure 7 shows the recorded maximum ground accelerations (E-W component) and the Ambraseys (1995) empirical curves. From the plotted curves, one can deduce the followings :

- The mean curve of the Ambraseys law underestimate largely the recorded accelerations for all distances.
- The envelop curve of Ambraseys law underestimate the recorded acceleration up to 70 km, while it captures the trend of the recorded accelerations from 70 km.

It is clear that for certain accelerations (stations of Keddara, Dar El Beida, El Afroun), the amplification effect explains the significant variation with the empirical curves of Ambraseys, 1995.

CONCLUSION

The earthquake which shook the areas of Algiers and Boumerdes (Mw = 6.8, USGS) on May 21 2003, is regarded as the major earthquake which occurred in this area of Algeria at least since two century, and the second of this importance after El Asnam October 10, 1980 (Ms = 7.3) earthquake. The main shock was felt 250 km far from the epicentre, and was recorded by several accelerograph stations of the national network monitored by the CGS.

Analysis of the recordings of the strong movements allows to conclude what follows :

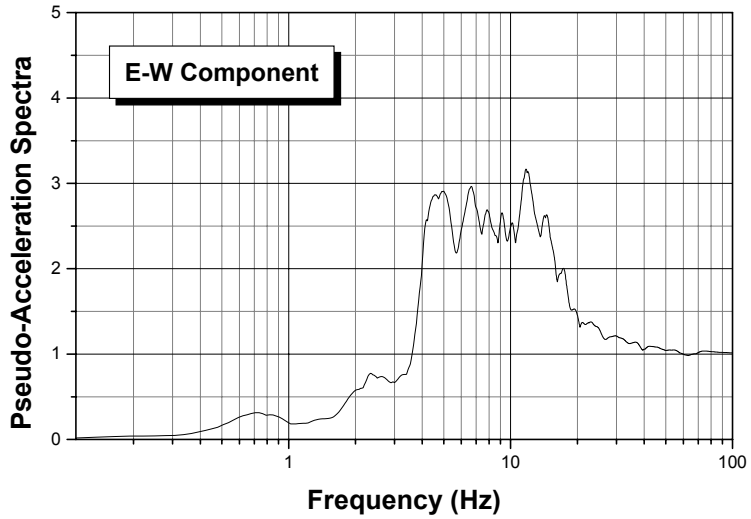
(i) A significant variation observed between two stations distant from each other approximately 150 m. A current geotechnical study will quantify this local site effects.

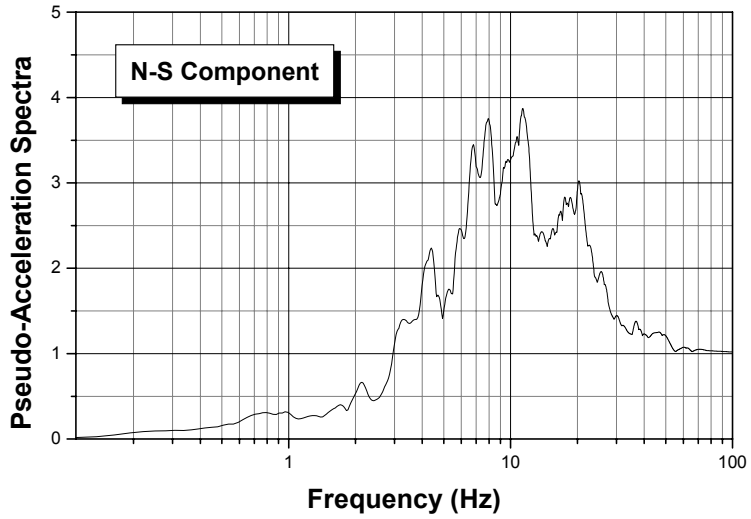
(ii) PGA in E-W direction are more significant than those in the N-S direction. This observation is probably related to the directivity effect of the fault.

(iii) Stations located on the Mitidja quaternary basin classified as soft soils such as the Dar El Beida and El Afroun stations records show high acceleration level compared to those located on firm soils.

(vi) A comparative study show that the attenuation law of Ambraseys (1995) underestimate largely the recorded data during the main shock of the may 21 2003 Boumerdes earthquake.

On the other hand, this earthquake induced liquefaction mainly along the Isser and Sebaou river valleys and tsunamis in the Balearic islands as well as uplift of the coastal line.





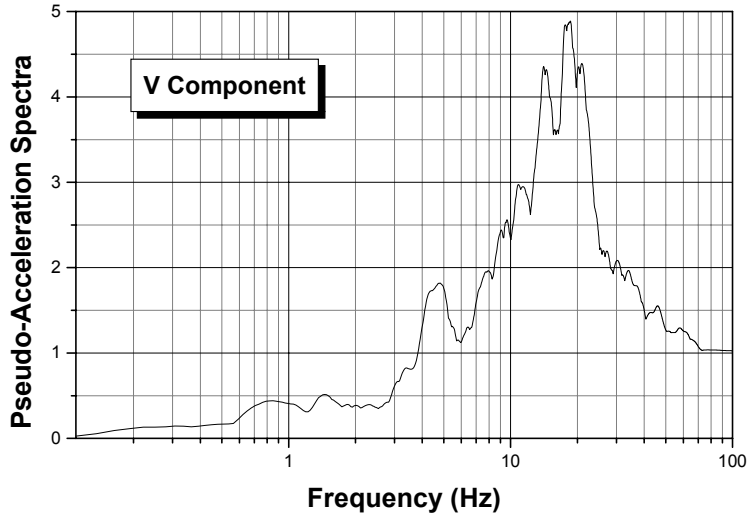


Figure 6 : E-W, N-S and Vertical pseudo accelerations response spectra at Keddara 1 station.

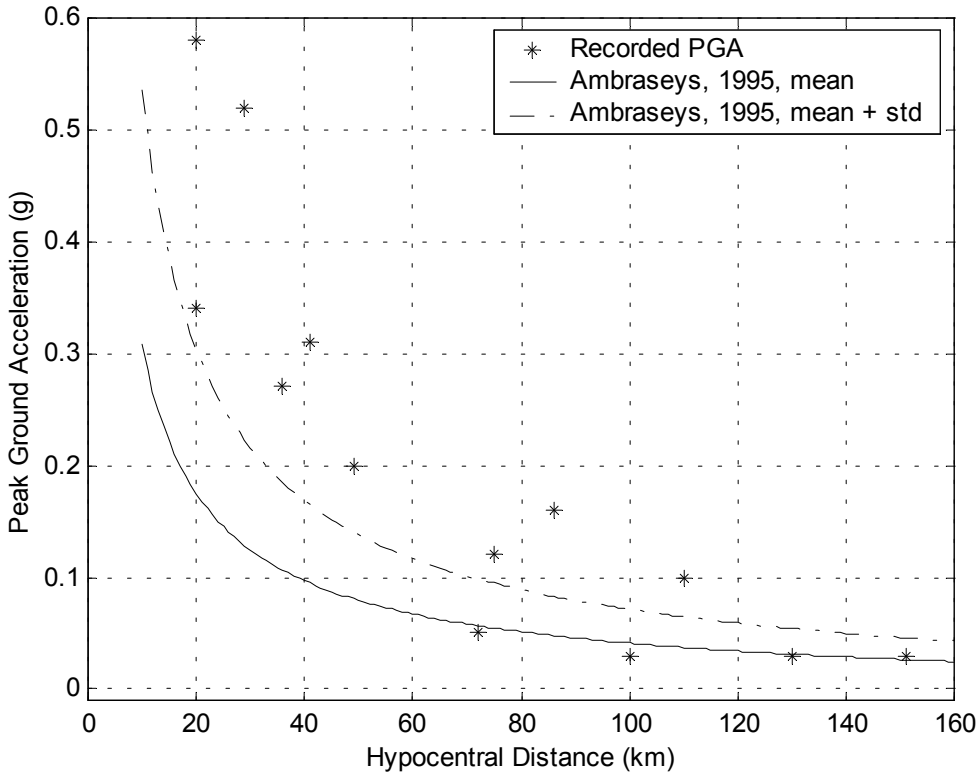


Figure 7 : Comparaison between the Recorded PGA attenuation with the mean and the mean plus std empirical Ambraseys attenuation law (1995).

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