A Case Study of Accelerometric Records Analysis of May 21st, 2003, Boumerdes (Algeria) Earthquake

Abdelwahab Mourad Khellafi, Department of Civil Engineering, University of Djelfa, Djelfa, Algeria
Zamila Harichane, Geomaterials Laboratory, Department of Civil Engineering, University of Chlef, Chlef, Algeria
Hamid Afra, Building Research Center, CNERIB, Algiers, Algeria
Amina Sadouki, Geomaterials Laboratory, Department of Civil Engineering, University of Chlef, Chlef, Algeria

ABSTRACT

On May 21st, 2003, the north Algeria was stricken by a 6.8 magnitude earthquake which was felt over a distance of 250 km from the epicenter, which is localized in Mediterranean Sea at 10 km from the coast. During this event, several ground accelerations were recorded by the instrumentation network of the National Center of Applied Research in Earthquake Engineering (CGS). The records analysis revealed an important difference in peak ground acceleration (PGA) between two close stations (0.58g and 0.33g, respectively, in East-West direction) at about 20 km from the earthquake epicenter. Also, two other record stations, located in the Mitidja basin, at about 29 km and 86 km from the earthquake epicenter, respectively, showed a high level of acceleration: PGAs of 0.54g and 0.16g. So, the authors attempt in this paper to analyze these records through the characteristics of strong ground motions, the effects of different parameters such as damping ratios, soil conditions and epicentral distance on normalized response spectra. Also, the quantification of site effects during this earthquake is analyzed. Then, the authors compare the near-field mean response spectra obtained during this earthquake with the Algerian seismic design spectra (RP A99 – 2003 version) and with two other well-known design spectra: Eurocode 8 and UBC97 in order to contribute to the future revision of RP A99.

Keywords: Boumerdes Earthquake, Design Response Spectra, Free Field Record, Site Effect, Spectral Ratio

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INTRODUCTION

Algeria is one of the most active areas in the Mediterranean basin where occur periodically major earthquakes (Algiers, 1716; Oran, 1790; Djidjel, 1856; El Asnam, 1954/1980; Boumerdes, 2003; Ambraseys & Vogt, 1988; Maouche et al., 2008).

On May 21st, 2003, the Algiers-Boumerdes region in north Algeria was stricken by a major earthquake of 6.8 magnitude on the Richter scale. The main shock has induced damage spread mainly in the region of the Eastern part of Algiers Capital. It was felt until 250 km from the epicenter which was localized at sea. Peak ground accelerations (PGA) in East-West (E-W), North-South (N-S) and Vertical (V) directions of 0.58g, 0.34g and 0.22g, respectively, were recorded at Keddara station at approximately 20 km from the earthquake epicenter. At approximately 150 m of this station, peak ground accelerations of 0.33g, 0.26g and 0.25g in (E-W), (N-S) and (V) direction, respectively, were recorded. It’s important to conduct more exhaustive studies to understand the difference in PGA between the two close stations. For this purpose, the present study is conducted in order to analyze these records through the characteristics of strong ground motions, the effects of different parameters such as damping ratios, soil conditions and epicentral distance on normalized response spectra and the quantification of site effects during this earthquake. We, also, compare the near-field mean response spectra obtained during this earthquake with the Algerian seismic design spectra (RPA99 – 2003 version) and with two other well-known design spectra: Eurocode 8 and UBC97 in order to contribute to the future revision of RPA99. These several records were obtained by the instrumentation network of the National Center of Applied Research in Earthquake engineering (CGS) in Algiers.

The very important variation in observed PGA between the two stations, Keddara 1 and Keddara 2 (Table 1), concerns more particularly accelerations in (E-W) direction; what could be explained by a presence of an important site effect particularly at Keddara 2 station. However, accelerations in (E-W) direction are largely higher than those in (N-S) direction for almost the whole stations which recorded the main shock. This observation is related to the fault directionality (Laouami et al., 2006).

The high level of released energy during the main shock ($M_w = 6.8$) explains the raised levels of acceleration, particularly for near and intermediate fields. In intermediate field, at Dar El Beida station (29 km), PGAs of 0.54g, 0.16g and 0.50g are obtained in (E-W), (V) and (N-S) directions, respectively. At Hussein Dey station (36 km), PGAs in the same directions are, respectively, 0.27g, 0.09g and 0.23g. In far field, at Blida station (72 km), PGAs in (E-W), (V) and (N-S) directions are, respectively, 0.046g, 0.028g and 0.038g, and at El Afroun station (86 km), there are 0.16g, 0.03g and 0.09g PGAs in the same directions.

Just after the main shock, a mobile station was installed at Boumerdes Town, about 7 km from the epicenter, by the CGS. Noting that during the May 27th, 2003 aftershock ($M = 5.8$), PGA of 0.29g, 0.4g and 0.13g in (E-W), (V) and (N-S) directions, respectively, were recorded at the Boumerdes station. Since the station is located in epicentral zone and due to E-W fault directionality observed in this zone, the vertical component amplitude is greater than the horizontal components and the E-W component is higher than the N-S component (Maouche et al., 2008; AFPS, 2006).

The Algerian seismic design code RPA99 (2003-version) (RPA, 2003) defines four (04) site types (S1, S2, S3 and S4). Thus, we present in this paper a comparison study between normalized response spectra obtained in near field during the May 21st, 2003 Boumerdes earthquake and design spectra given by the Algerian Regulatory Rules RPA99 (2003-version) (RPA, 2003), the Eurocode8 (Eurocode, 1998) and the Uniform Building Code (UBC1997) (UBC, 1997). The principal objective of this comparison is to emphasize differences which can be observed between the earthquake design spectra of the three seismic design codes and those obtained from accelerometric records.
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