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Introduction of the Harmfulness of the Seismic Signal in the Assessment of the Performance of Reinforced Concrete Frame Structures

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***Abstract*—**The principle of the seismic performance evaluation methods is to provide a measure of capability for a building or set of buildings to be damaged by an earthquake. The common objective of many of these methods is to supply classification criteria. The purpose of this study is to present a method for assessing the seismic performance of structures, based on Pushover method; we are particularly interested in reinforced concrete frame structures, which represent a significant percentage of damaged structures after a seismic event. The work is based on the characterization of seismic movement of the various earthquake zones in terms of PGA and PGD that is obtained by means of SIMQK_GR and PRISM software and the correlation between the points of performance and the scalar characterizing the earthquakes will developed.

***Keywords*—**Seismic performance, Pushover method, characterization of seismic motion, harmfulness of the seismic signal.

I. Introduction

EARTHQUAKES have occurred recently in the world, have revealed the vulnerability of old structures. It will be interesting to assess the vulnerability of these buildings in Algeria, to reduce the seismic risk to our cities [3]. This research mainly concerns the reinforced concrete frame structures built before the introduction of seismic standards in 1988 [3]. The main objective is the evaluation of the seismic performance of reinforced concrete frame buildings, which requires: The request, as a response spectrum obtained from Algerian seismic code [3]. The capacity, in the form of a non-linear curve obtained from the technique called "Pushover" [1], [2]. Reducing the danger of vibrations of the ground on structures requires a good estimate of the seismic loading, which these structures are subjected. Usually, the most used settings for their design are the peak ground acceleration (PGA) and the maximum displacement (PGD) [6]-[8].

II. Peak Ground Acceleration

The value of Peak Ground Acceleration (Fig. 1) is the first parameter that was the basis for the classification of records [11]. Where many studies to find correlations between this term and the damage has been developed. This factor cannot represent alone the destructive power of an earthquake, as it was found moderate damages after major earthquakes. Conversely, some minor earthquakes produced massive destruction. Intuitively, one might think that the level parameter is not enough. Indeed, if lower levels of earthquake are kept long, the effect could be catastrophic.

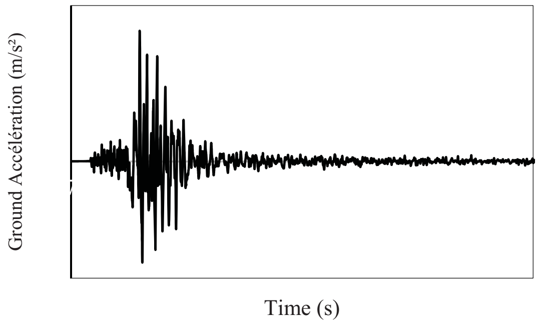

Fig. 1 Ground acceleration versus time

III. Peak Ground Displacement

The Peak Ground Displacement gives an idea of the magnitude of the relative displacement of center of gravity of the structure (Fig. 2) relative to its base: a few centimeters in low seismicity zone to a meter in highly seismic zone [7].

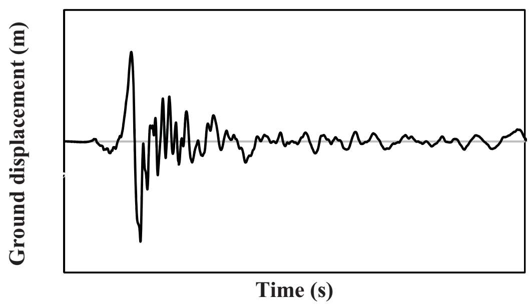

Fig. 2 Soil displacement versus time

The duration of the earthquake related to the magnitude, is a significant parameter in the cracking process and progressive degradation of the components of a construction. The latter is

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maximum, to about 60 seconds in very seismic zone, but is only a few seconds in some low seismic area [9].

IV. Creating a Synthetic Signal

Database as the creating of a natural earthquake database is complex; it was decided to create basic accelerometer signals, generated synthetically.

V. The Softwares

SIMQKE_GR is used to generate the synthetic signal [10]. Its principle is to build the spectrogram of simulated signals, by analogy with the RPA response spectra 99 for the four types of soil, thereafter PRISM software 'for Earthquake Engineering' 'is used to estimate the PGA and PGD [4], the parameters characterizing the earthquakes.

VI. Used Procedure

This work presents an outline of the procedure followed. The difficulty in understanding this process is the fact that the digital data are extremely wide, and so keep in mind some logic rankings. The schematic diagram (Fig. 3) shows a limited way, the path of the procedure in folders and subfolders. A program that includes all procedures permits, with the five accelerations for the four soil classes [3], to obtain a database of artificial earthquakes of forty (40) accelerograms [5].

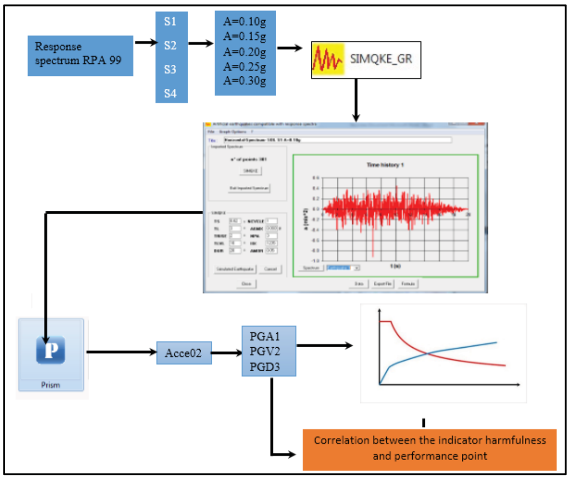

Fig. 3 Schematic diagram of the procedure

VII. Presentation and Description of the Building

The building is used for housing, made up of reinforced concrete frames (columns, beams) with masonry in fills (Fig. 4).

All columns have the same cross section dimensions (35x35) cm², their reinforcement is show in Fig. 5 [5].

VIII. Illustration Results

The graphs below show the behavior of the structure under study, according to the peak ground acceleration PGA for the four types of sites S_1, S_2, S_3 and S_4, which are classified according to the Algerian earthquake regulation in rocky sites, farm, loose and very loose [3].

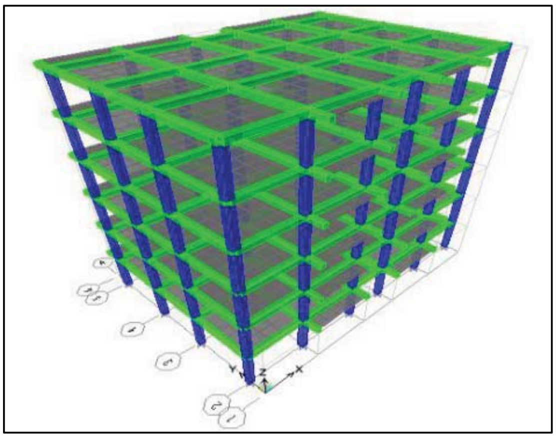

Fig. 4 3D view of the structure studied

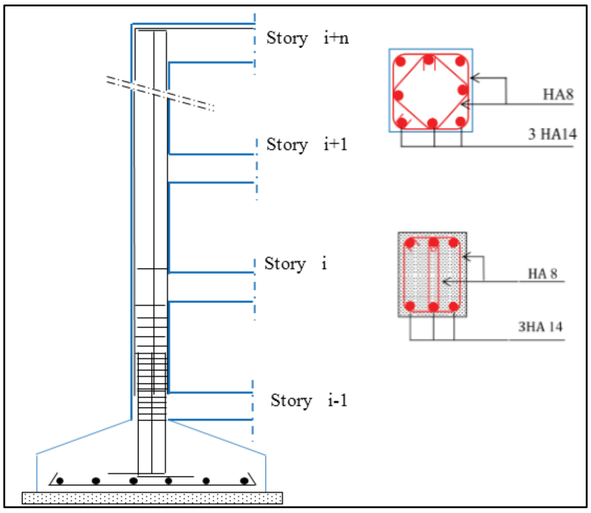

Fig. 5 Detail reinforcement elements of the structure studied

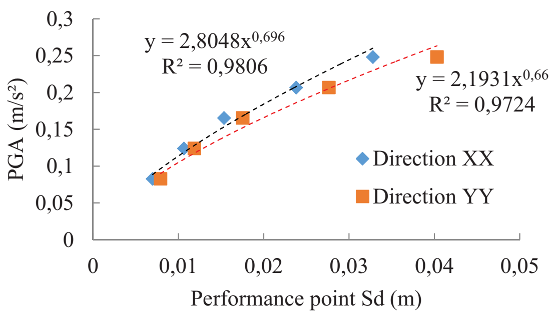

Fig. 6 Variation of PGA according to the performance point (soil S_1)

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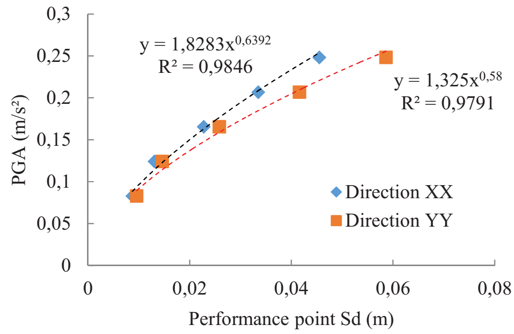

Fig. 7 Variation of PGA according to the performance point (soil S_2)

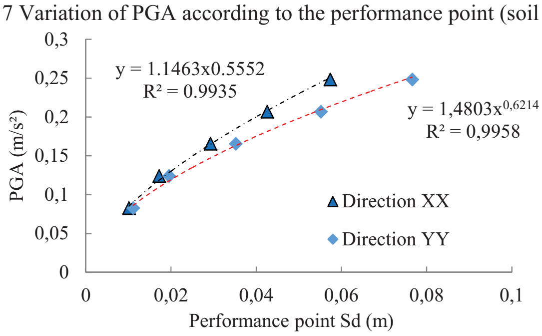

Fig. 8 Variation of PGA according to the performance point (soil S_3)

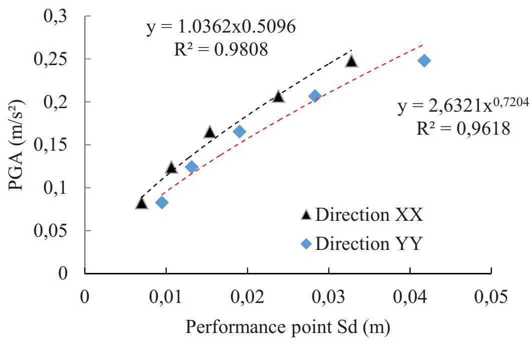

Fig. 9 Variation of PGA according to the performance point (soil S_4)

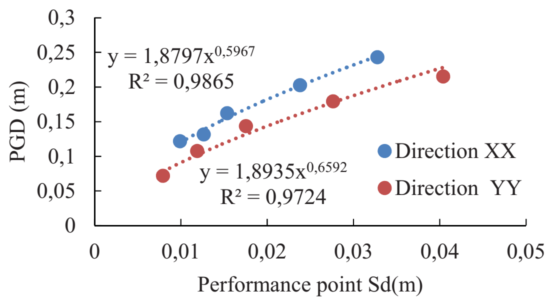

Fig. 10 Variation of PGD according to the performance point (soil S_1)

Based on visual analysis of graphs, we see that the behavior of the displacement field structure varies from floor to another through a rocky site furniture or very loose site, as well as increased displacement i.e. that the performance of the structure decreases with the decrease in the mechanical characteristics of the soil.

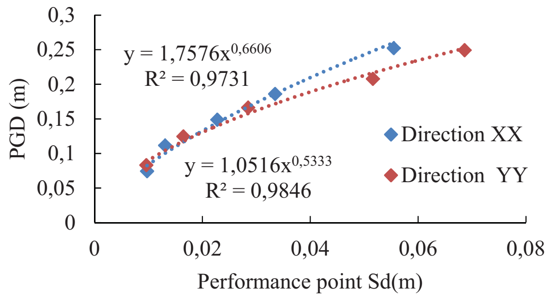

Fig. 11 Variation of PGD according to the performance point (soil S_2)

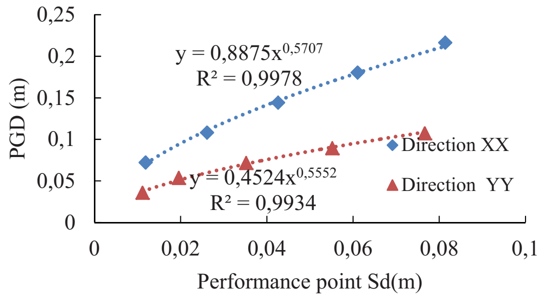

Fig. 12 Variation of PGD according to the performance point (soil S_3)

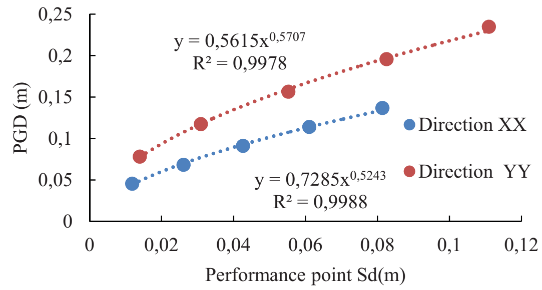

Fig. 13 Variation of PGD according to the performance point (soil S_4)

The elaborate graphs allow understanding the behavior of a structure knowing his performance point for an earthquake characterized PGA or PGD. PGA approximation functions and DMP based on the performance point have correlation coefficients R^2 between 0.97 and 0.99 for the soil S1, (R^2) between 0.98 and 0.99 for the S_2, S_3, and ground to a ground S_4 (R^2) between 0.97 and 0.99

The approximation functions developed for each soil type are functions as power $Y = a X^b$ or a and b are coefficients of determination which essentially depends on the mechanical characteristics of implantation of the soil to have the shear rate; the higher the speed the greater the determination coefficients increase.

Uncertainty about performance of structures during an earthquake characterized by a harm indicator was summarized by evaluating the correlation factors for performances (Sd-IN) established. These correlation factors can be directly read from the graphs in logarithmic scale.

IX. Conclusion

The study was conducted on a reinforced concrete frame structure by Pushover method in order to highlight some essential criteria such as the influence of soil on the shear rate and the response of the structure on movement (performance point).

It is noticed that more the implantation soil is loose more the shear wave velocity is low, so the structure has a major vulnerability index. The study has mainly resulted in the development of a performance estimation model based on harm indicators and performance point, which allows us to understand realistically the behavior of reinforced concrete frame structures, under seismic action.

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