8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

USING THE PIANO KEYS SOUND AS ARTIFICIAL ACCELERATIONS

Ali KIA
Assistant Professor, Civil Engineering-Earthquake, Golestan Institute of Higher Education, Gorgan, Iran
ali.kia.cien@gmail.com

Amin BAI
M.Sc. of Civil Engineering-Structure, Golestan Institute of Higher Education, Gorgan, Iran
big.end.94@gmail.com

Reza KIA
Ph.D. Candidate, Golestan Institution of Higher Education, Gorgan, Iran
r.kia1989@yahoo.com

Keywords: Piano keys sound, Artificial acceleration, Response spectrum, Frequency content

Bartolomeo Christophorus invented the piano in about 1700 in the city of Padova, Italy. But the new invention of Christophy remained nearly unknown for about a decade until in 1711 an Italian author wrote an article about it, later translated into German and published extensively. This article also included a piano mechanism diagram, and most of the piano-makers started their work on this article. Before the invention of the piano, the older version was called Harpsichord (Cyril, 1990). In this research, the sound of the six random parts of playing a piece of piano that has the initial landing, up and down the secondary is randomly selected and considered as artificial records. In this selection, we try to consider the effect of the interference of the notes on each other, which helps to overcome the sound. In order to verify the accuracy of artificial records, it is necessary to compare the data with actual earthquake records. Therefore, for the purpose of this, six near-field records have been selected considering the pulse effect for the second type soil. Information on record characteristics of both domains is shown in Table 1.

Table 1. Specifications for selected records for the near field (PEER NGA Database, 2019).

No.	Record number	Incident name	Station name	Date of occurrence	Effective movement time (s)	Magnitude (Richter)	Distance to fault (km)	Fault type	Shear wave velocity (m/s)
1	285	Irpinia,Italy-01	Bagnoli Irpinio	1980	19.6	6.9	8.14	Normal	649.67
2	292	Irpinia, Italy-01	Sturno (STN)	1980	15.2	6.9	6.78	Normal	382
3	802	Loma Prieta	Saratoga- Aloha Ave	1989	9.4	6.93	7.58	Reverse Oblique	380.89
4	1052	Northridge-01	Pacoima Kagel Canyon	1994	10.1	6.69	5.26	Reverse	508.08
5	3473	Chi-Chi, Taiwan-06	TCU078	1999	7.4	6.3	5.72	Reverse	443.04
6	4228	Niigata, Japan	NIGH11	2004	12.2	6.63	10.2	Reverse	418.5

The response spectrum has been used to evaluate and compare the artificial records with actual earthquake records. Therefore, the response spectrum for the selected records for the domain is shown in Figure 1.

In order to evaluate and compare the artificial records derived from piano keys with the major records of earthquakes, a comparative coefficient is required. The results on different data show that the best factor for evaluating independent indicators in statistics science is the coefficient of correlation coefficient. The correlation coefficient is a statistical tool for determining the type and degree of the relationship of a quantitative variable with a slightly different variable. Correlation coefficient is one of the criteria used to determine the correlation between two variables. Correlation coefficient shows the severity of the relationship as well as the type of relationship (direct or inverse). This coefficient is between 1 and 1, and in the absence of a relationship between the two variables, is equal to zero.

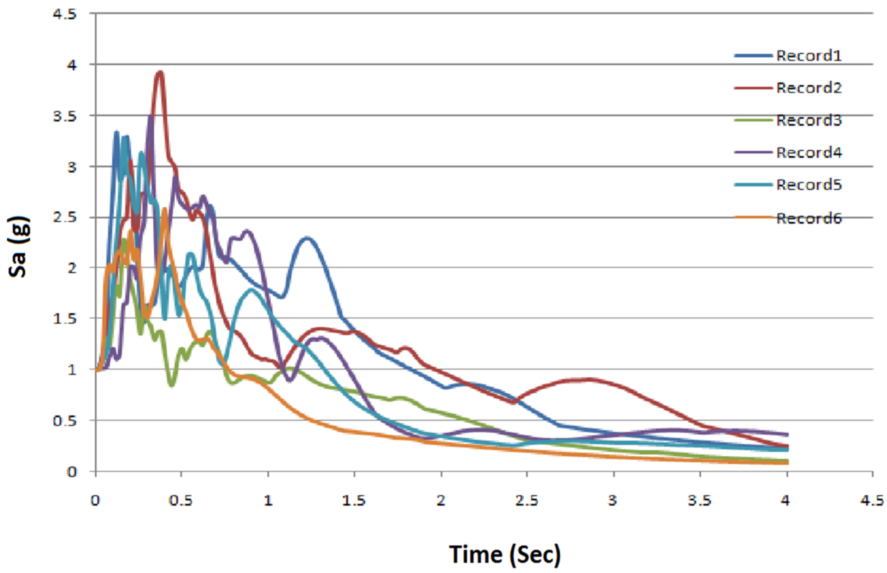

Figure 1. Charts of the response spectrum of the six selected records for the near field.

The relationship between determining the correlation coefficient used in this study is as follows.

$$\mathrm{Corr}(X,Y) = \frac{\mathrm{Cov}(X,Y)}{\sigma x \sigma y} = \frac{E[(X-\mu x)(Y-\mu y)]}{\sigma x \sigma y} \quad (1)$$

In this relation E is the operator of mathematical hope, cov means covariance, corr is the usual symbol for Pearson correlations, and Sigma is the standard deviation symbol.

The comparison between the near field records and the piano sound recordings showed that the highest correlation with the Loma Prieta, Niigata, Japan and Chuetsu-oki, Japan earthquakes is about 60%. Also, the lowest correlation for the Northridge earthquake is about 30%.

REFERENCES

Cyril, E. (1990). *The Piano: A History*. USA: Oxford University Press.

Pacific Earthquake Engineering Research Center (PEER) (2019). NGA Database, https:// ngawest2.berkeley.edu.