CAN THE EXTRACTED LOW-FREQUENCY PULSES PREDICT THE SEISMIC RESPONSE OF STRUCTURES?

Salar ARIAN MOGHADDAM
PhD Candidate, IIEES, Tehran, Iran
s.arianmoghaddam@iiees.ac.ir

Gholamreza GHODRATI AMIRI
Professor, Center of Excellence for Fundamental Studies in Structural Engineering, School of Civil Engineering, Iran University of Science and Technology, Tehran, Iran
ghodrati@iust.ac.ir

Keywords: Near-Fault, Velocity Pulses, Seismic Response

New methods for time-frequency analysis of time series providing local information of signals, allow earthquake engineers to study both the input and output of dynamic time history analysis in a more reliable way. This issue may become more important in case of the study of the sensitivity of frame structures to the frequency content of ground motions. Time-Frequency Representatives (TFRs) have a major role in the analysis of non-stationary seismic signals with time variation of frequency content.

S-Transform (ST) is a modern TFR, which can measure local characteristics of a signal such as amplitude, frequency, and phase at any time instant (Stockwell, 1996). This paper presents a new filtering approach using the ST to capture the low and high frequency parts of near-fault ground motions. The influence of each part on the seismic behaviour of frame structures is investigated as well as the spectral characteristics.

A justified version of ST-based technique, originally employed to extract the directivity based velocity pulses (Ghodrati Amiri and Arian Moghaddam, 2014) is introduced and applied to compare the seismic response of structures under pulses, residuals and original ground motions. Structural details of frames are selected from Dimopoulos et al. (2012).

The results confirm the past findings about the role of the ratio between the pulse period and natural period of buildings in the high observed seismic responses in near-fault events. Also, the results show that, in some cases, there are other high or even low frequency portions in a near-fault accelerogram which can excite the structures with natural periods out of the proposed range in literature or cause the excitation of higher modes of vibration.

Figure 1 depicts the result of spectral parameters computed for the low and high frequency parts of accelerogram compares the original signal. Figure 2 shows the critical ratio at which the dominant portion of accelerogram which controls the seismic response changes. Figure 3 illustrate different frequency bands which have the potential of seismic excitation in time-frequency domain as the output of ST analysis.

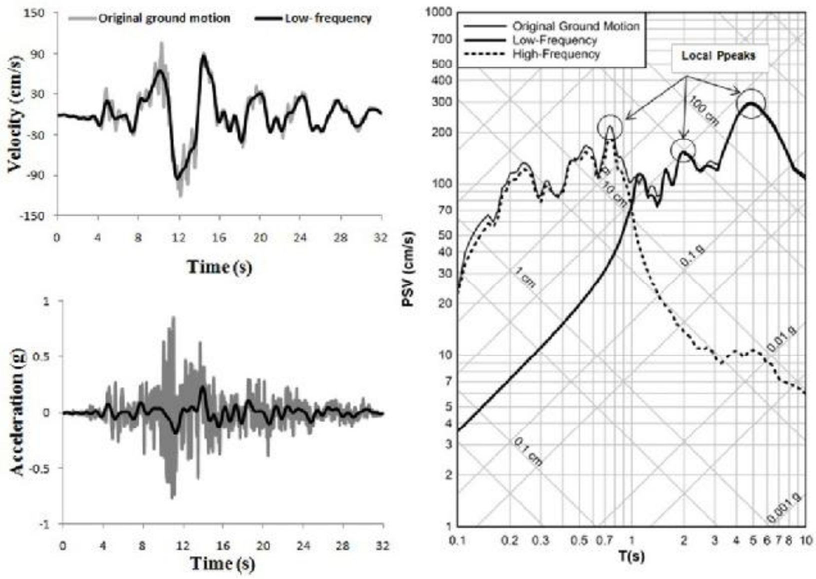

Figure 1. The filtered low and high frequency parts of ground motion compared to the original signal for Tabas accelerogram

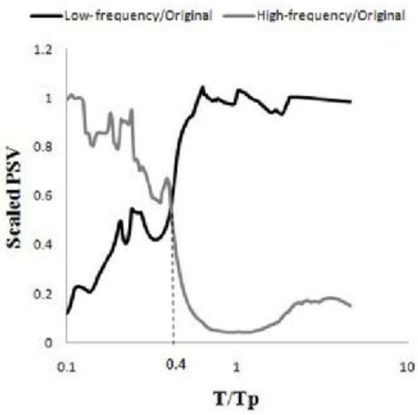

Figure 2. Determination of the critical ratio of the pulse period and natural period for Tabas accelerogram

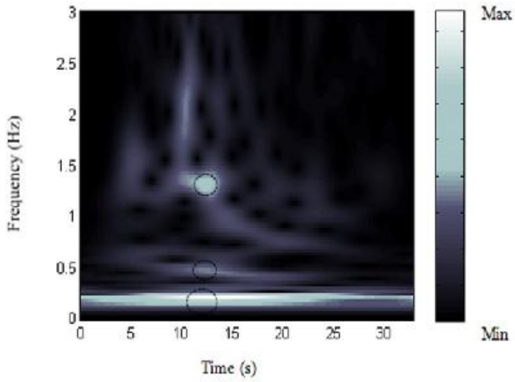

Figure 3. The frequency bands existing in the pulse-like part of Tabas accelerogram

REFERENCES

Dimopoulos AI, Bazeos N and Beskos DE (2012) Seismic yield displacements of plane moment resisting and x-braced steel frames, *Soil Dynamics and Earthquake Engineering*, 41: 128-140

Ghodrati Amiri G and Arian Moghaddam S (2014) Extraction of forward-directivity velocity pulses using S-Transform-based signal decomposition technique, Bulletin of Earthquake Engineering: DOI: 10.1007/s10518-013-9581-x

Stockwell RG, Mansinha L and Lowe RP (1996) Localization of the complex spectrum: the S transform, IEEE Trans Signal Process, 44(4):998–1001, doi:10.1109/78.492555