Undergraduate Research Symposium 2k20

MURS Mahindra University Research Symposium 2020

Time Frequency Analysis of Strong Ground Motions from the 30th October 2020 Turkey Earthquake

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Introduction:

- The earthquake struck on Friday, 30 October 2020 hit western province of İzmir, Turkey had an about 14km northeast of the Greek island of Samos.
- The earthquake occurred as a result of purely normal faulting at a shallow crustal depth within the Eurasian plate in the eastern Aegean Sea, about 250 km north of the closest main plate boundary, where the African Plate moves to the north at a rate of approximately 10 mm per year with respect to the Eurasian.
- Its is an intraplate earthquake which occurs within the body of plate away from plate boundary.
- These occur due to reactivation of ancient faults within the body of plate because of compressional stresses generated.
- The continuous wavelet transform (CWT) is utilized to understand the changing time-frequency characteristics of earthquake ground motions.

Event Details

EVENT NAME	202010301151
EVENT DATE (YYYYMMDD)	2020/10/30
EVENT TIME	11:51:24.000
EPICENTER LOCATION	37.8881, 26.777
EVENT DEPTH (Km)	16.54
MAGNITUDE	6.6
TSUNAMI	yes

Methods:

- Since earthquake ground motions are non-stationary, i.e. their frequency content varies with time, both the time-domain and frequency-domain representations convey partial information.
- The wavelet transforms, e.g. the continuous wavelet transform (CWT), provides information on both the time and frequency content of non-stationary signals.
- CWT graphs show the time-period or frequency on y-axis, time on x axis and the colour represent the amplitude.

Observation:

STATION CODE	EPICENTRAL DISTANCE (km)	PGA (cm/s^2)
0905	42.95	179.3136
3528	55.4	149.3083
3518	72.48	106.103
3519	73.08	150.0886
3521	73.17	110.8436
3513	76.14	106.2815

Table 1. Key characteristics of strong ground motions for 6 stations (having PGA > 0.1g)

Plots of CWTs for Strong Ground Motions

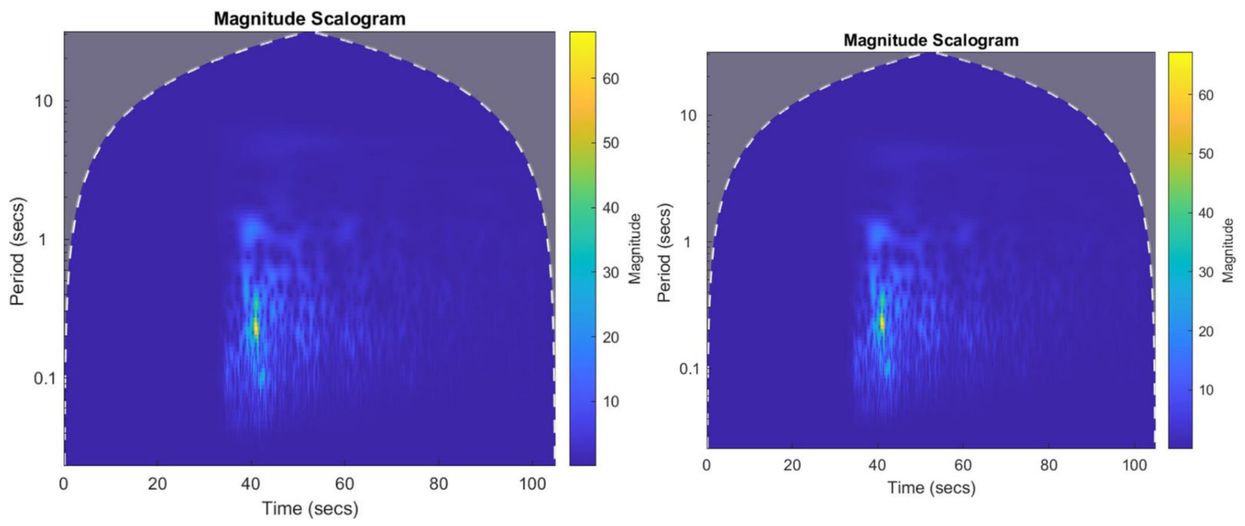

Figure 1 & 2: Continuous Wavelet Transform of Ground motions at station 0905 (L & T)

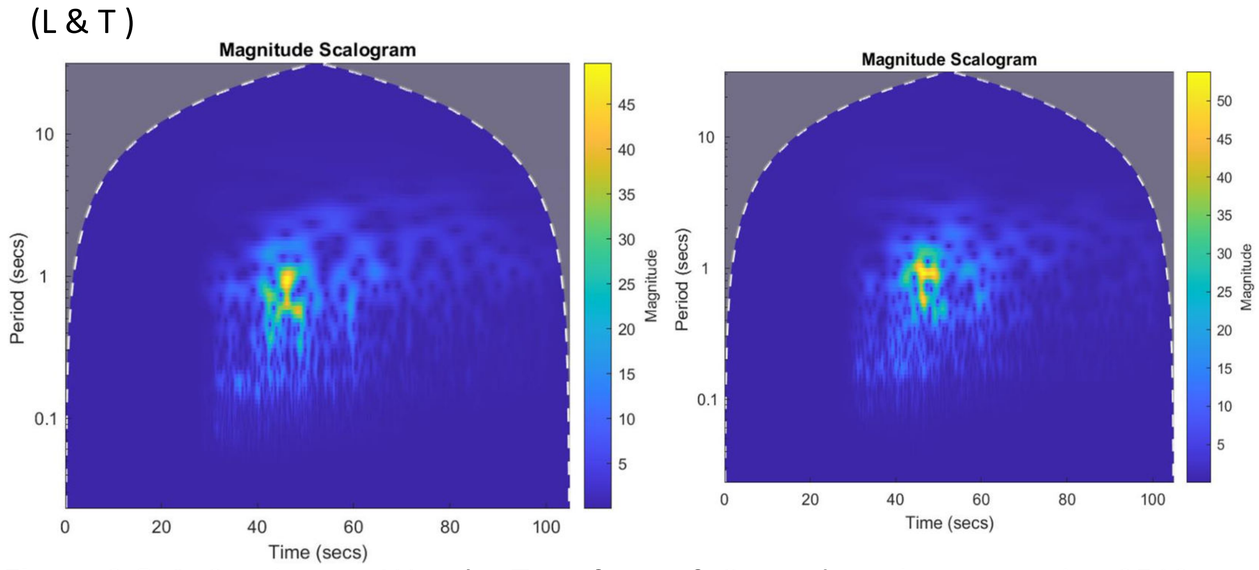

Figure 3 & 4: Continuous Wavelet Transform of Ground motions at station 3519 (L & T)

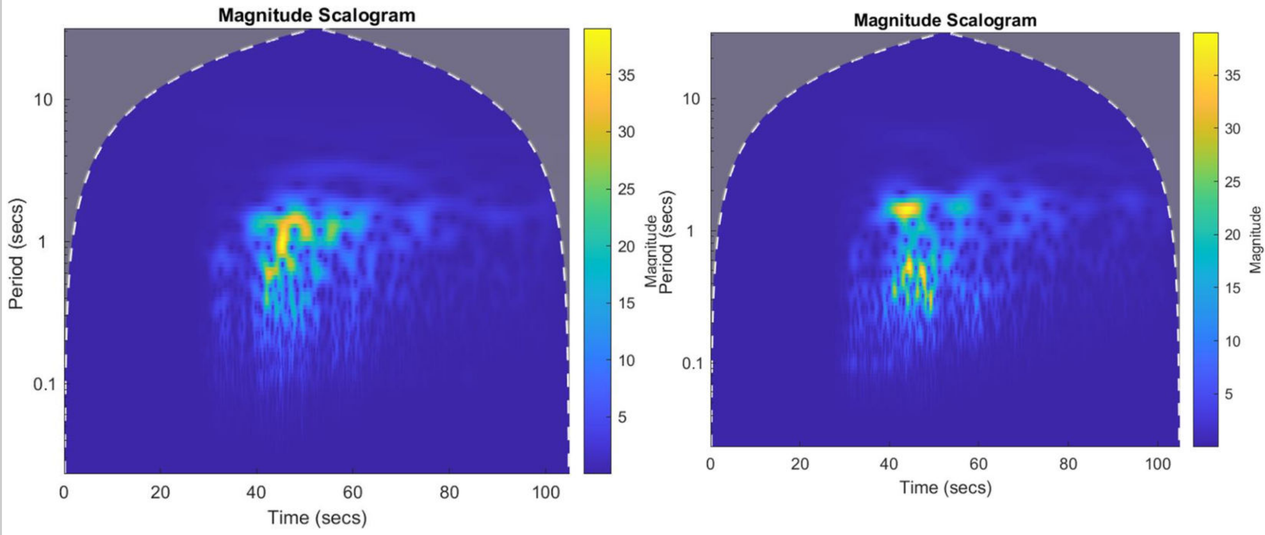

Figure 5 & 6: Continuous Wavelet Transform of Ground motions at station 3513 (L & T)

Conclusions:

- Wavelet analysis enable us to understand seismic waves in both time and frequency domains. The gradient of the plot provides a representation of the magnitude of the wave.
- While some ground motions exhibit high amplitude waves at the same frequency content over a significant duration of time, other ground motions exhibit high amplitude waves in two to three frequency ranges.
- First subjected to waves having high frequency, i.e. low periods and later by waves of low frequency, i.e. high periods, the structure will have enhanced damage. This need to be examined by comparing with the the resonating period of structure.

Important References:

- https://tadas.afad.gov.tr/
- *"M 7.0 – 14 km NE of Néon Karlovásion, Greece". Earthquake. Retrieved 30 October 2020*

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