Regression analysis for Duration-Hypocentre Distance Relationship for 3 recent Earthquakes in Japan

Akash Kharita

17411002

Indian Institute of Technology, Roorkee -247667

1 September, 2020

Introduction

When an earthquake occurs, energy releases and records on seismographs and accelerographs in the form of various surface and body waves, the shape produced by these waves on accelerographs can be represented by some envelope function containing peak ground acceleration (PGA) and a characteristic Duration.

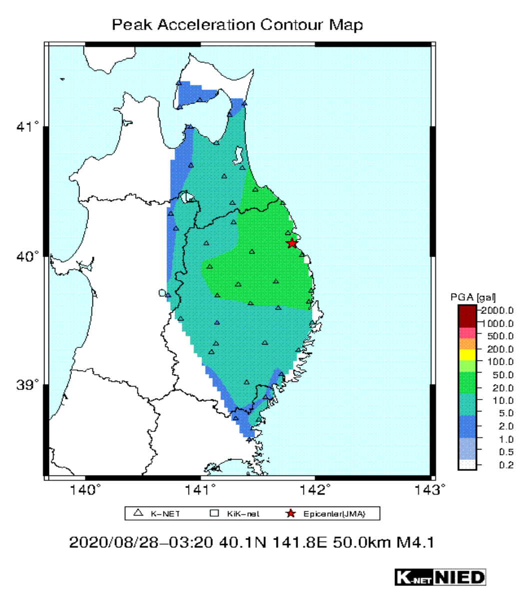
Duration of these envelope function turns out to be dependent on Magnitude of Earthquake and Hypocentral distance of the recording station as given by Midorikawa(1993) such dependency can be represented in the form of empirical relationship. The parameters of this empirical relationship provide insights about attenuation characteristics of the region.

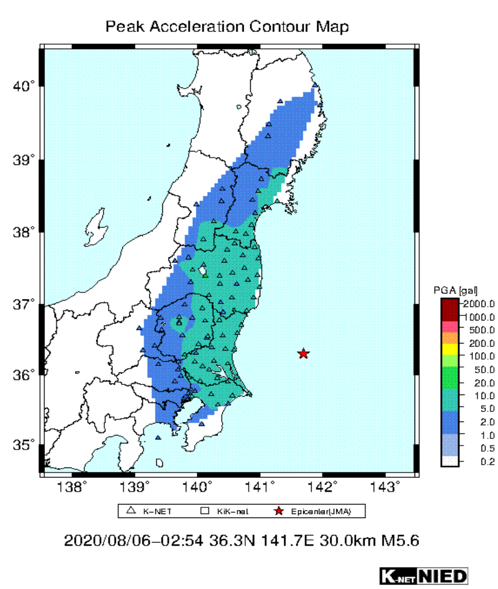
I am using one of the empirical relationships provided by Midorikawa (1993) for Japan. Given below-

$$T_d = (0.0015)10^{0.5M} + aR^b \qquad - (1)$$

Here Td represents duration of envelope in seconds, M represents magnitude of Earthquake, R represents Hypocentral distance in (Km). a, b are empirical parameters and can be found by regression analysis.

It is expected that a and b should be positive , as due to increasing R , attenuation increases , waveform's amplitude decrease and spreading increases , therefore increasing the duration.





Here I present the regression analysis of 2 recent Japan Earthquakes , (i) M4.1 Earthquake at a depth of 50 Km on 28 August (ii) M5.6 Earthquake at a depth of 30Km on 6 August. (KNET station locations and PGA can be seen on adjacent figures for both Earthquakes.

Methodology

The strong motion data for all the 3 earthquakes were downloaded from KNET network of japan. The downloaded data came in the form of zipped files for each station which contained the zipped files of each station, which in turn contained 3 files for each component NS,EW,UD.

Data records were obtained at 43 sites in case of (i) and 102 sites in case of (ii).

All files were converted to .csv format using a single window command. Then a MATLAB function was built which will automatically take all the files ,extract the required information ,plot the graphs and fit a line using least square methods to find the values of parameters a and b.

The MATLAB code which I created can be found here - https://github.com/akashjat1062

The data was initially filtered, Constant values of duration with increasing Hypocentral distance were removed. Epicentral distance was calculated using Haversine formula, which is used for finding distance between two geographical coordinates.

The equations used in code are as follows

T_d-(0.0015)($10^{(0.5M)}$)= aR^b

Taking Logarithm of both sides we get

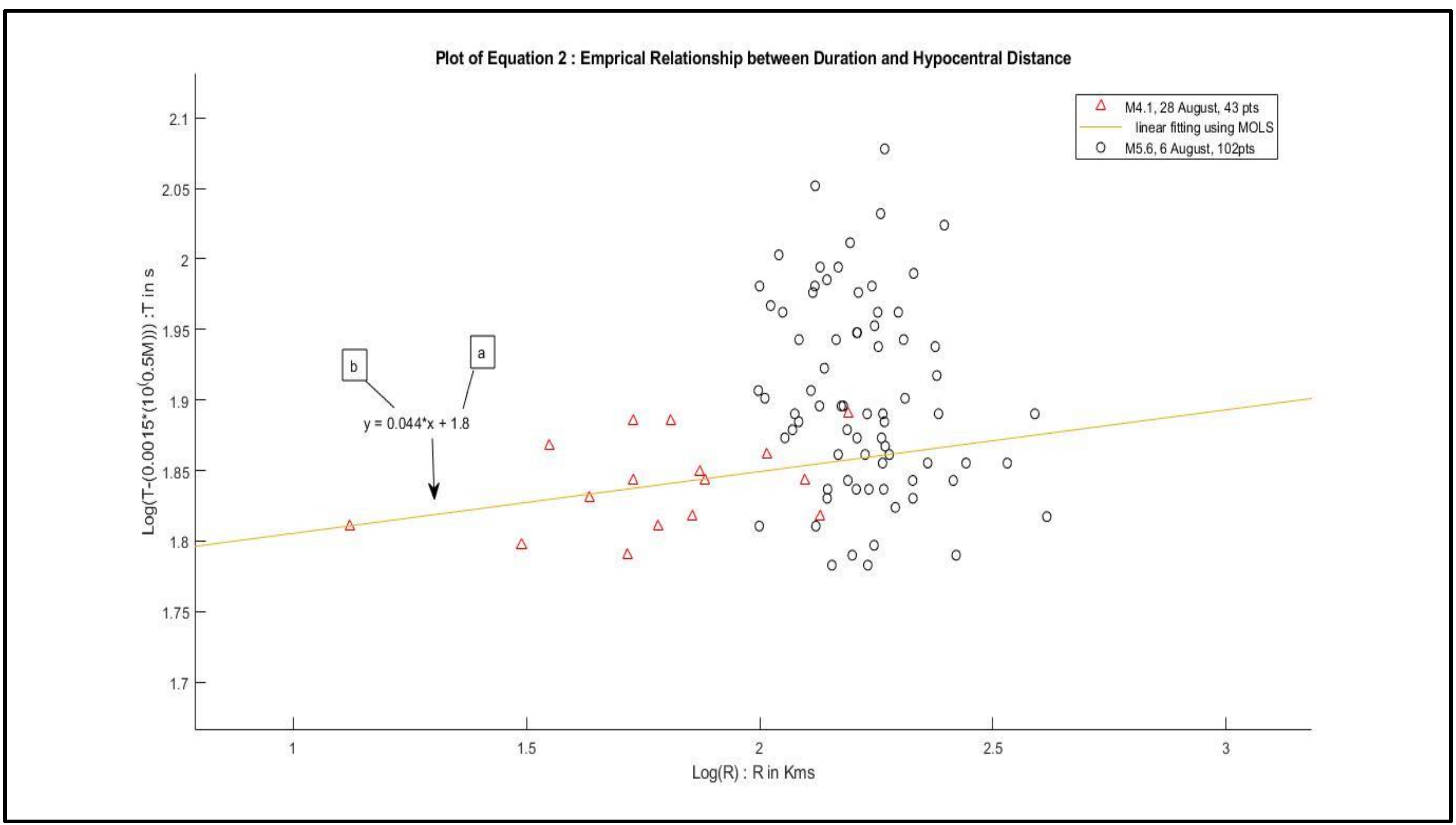
Log(Td-(0.0015)(10(0.5*M))) = Log(a) + bLog(R)   -(2)

This equation can be written in the form of a straight line as

Y = mX + C   - (3)

Here m = b and C = log(a)   - (3)

Data was plotted between Y an X and a straight line was fitted to find the values of parameters a and b (Figure 2).



Results and Conclusion

The values of a and b were found out to be 1.8 and 0.044, which is in a good agreement Joshi & Midorikawa(2004) which calculated the values to be 1.79 and 0.037 respectively.

High values of a and b for a region indicates the ground is highly attenuating and most of the seismic energy attenuates before reaching surface which is good for preventing the damage of life and property from earthquake.

References

Joshi, A., Midorikawa, S. A simplified method for simulation of strong ground motion using finite rupture model of the earthquake source. *J Seismol* **8,** 467–484 (2004). https://doi.org/10.1007/s10950-004-1595-z