Long Period Ground Motion

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***Abstract*: To study the effect of long period ground motion effect on structures and human life and the damages caused by the earthquake. Study earthquake type the wave produced during the earthquake. Instruments used to measure the earthquake and the case study of Nepal earthquake.**
Strong ground motions from the 2015 Mw 7.8 Gorkha, Nepal, earthquake and its eight aftershocks recorded by a strong-motion seismograph at Kantipath (KATNP), Kathmandu, were analyzed to assess the ground-motion characteristics and site effects at this location. Remarkably large elastic pseudo-velocity responses exceeding 300 cm/s at 5 % critical damping were calculated for the horizontal components of the main shock recordings at peak periods of 4–5 s.
Map and magnitude of different location are collected the analysed the Nepal Himalaya region.

1 INTRODUCTION :

An **EARTHQUAKE** (also known as a **quake**, **tremor** or **temblor**) is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to toss people around and destroy whole cities. The seismicity or **seismic activity** of an area refers to the frequency, type and size of earthquakes experienced over a period of time.

2. LONG PERIOD GROUND MOTION

Long period ground motion is ground movement during an earthquake with a period longer than 1 second. The frequency of such waves is 1 Hz or lower, placing them in the infrasonic part of the audio spectrum
High-frequency (short-period) ground motion is shaking where the ground moves back and forth very quickly. Long-period ground motion is shaking where it takes a longer time for the ground to move back and forth one cycle
There are three important characteristics of an earthquake motion; namely, amplitude, frequency content and duration. Amplitude represented with PGA has a direct impact but not necessarily the sole cause of structural damage. The same is true for frequency content; as the predominant frequency gets closer to natural frequency of the structure; damage probability increases but requires larger amplitude of input motion to be detrimental. On the other hand, SGMD and structural damage has no clear relation.

Seismologists usually define **strong ground motion** as the strong earthquake shaking that occurs close to (less than about 50 km from) a causative fault. The strength of the shaking involved in strong ground motion usually overwhelms a seismometer, forcing the use ofaccelerographs (or strong ground motion accelerometers) for recording. The science of strong ground motion also deals with the variations of fault rupture, both in total displacement, energy released, and rupture velocity.

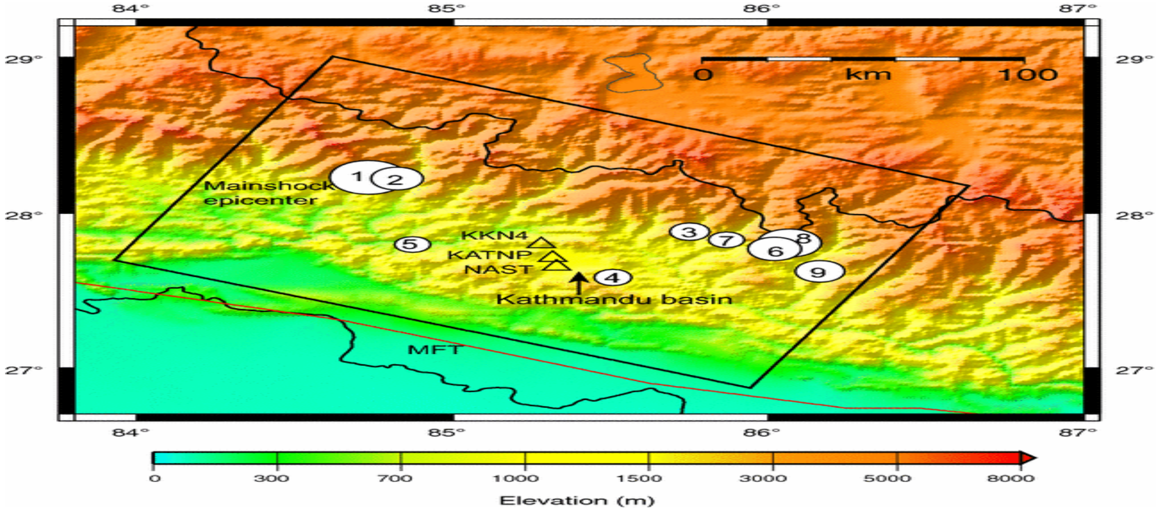
As seismic instruments (and accelerometers in particular) become more common, it becomes necessary to correlate expected damage with instrument-readings. The old Modified Mercalli intensity scale (MM), a relic of the pre-instrument days, remains useful in the sense that each intensity-level provides an observable difference in seismic damage.

After many years of trying every possible manipulation of accelerometer-time histories, it turns out that the extremely simple peak ground velocity (PGV) provides the best correlation with damage. PGV merely expresses the peak of the first integration of the acceleration record. Accepted formulae now link PGV with MM Intensity. Note that the effect of soft soils gets built into the process, since one can expect that these foundation conditions will amplify the PGV significant.

3. ANALYSIS OF LONG GROUND MOTIONS AND SITE EFFECTS AT KANTIPATH, KATHMANDU, FROM 2015 MW 7.8 GORKHA, NEPAL, EARTHQUAKE AND ITS AFTERSHOCKS:

Strong ground motions from the 2015 Mw 7.8 Gorkha, Nepal, earthquake and its eight aftershocks recorded by a strong-motion seismograph at Kantipath (KATNP), Kathmandu, were analyzed to assess the ground-motion characteristics and site effects at this location. Remarkably large elastic pseudo-velocity responses exceeding 300 cm/s at 5 % critical damping were calculated for the horizontal components of the mainshock recordings at peak periods of 4–5 s. Conversely, the short-period ground motions of the mainshock were relatively weak despite the proximity of the site to the source fault.
The horizontal components of all large-magnitude (Mw ≥ 6.3) aftershock recordings showed peak pseudo-velocity responses at periods of 3–4 s. Ground-motion prediction equations (GMPEs) describing the Nepal Himalaya region have not yet been developed. A comparison of the observational data with GMPEs for Japan showed that with the exception of the peak ground acceleration (PGA) of the mainshock, the observed PGAs and peak ground velocities at the KATNP site are generally well described by the GMPEs for crustal and plate interface events.
A comparison of the horizontal-to-vertical (*H*/*V*) spectral ratios for the S-waves of the mainshock and aftershock recordings suggested that the KATNP site experienced a considerable nonlinear site response, which resulted in the reduced amplitudes of short-period ground motions. The GMPEs were found to underestimate the response values at the peak periods (approximately 4–5 s) of the large-magnitude events.

The deep subsurface velocity model of the Kathmandu basin has not been well investigated. Therefore, a one-dimensional velocity model was constructed for the deep sediments beneath the recording station based on an analysis of the *H*/*V* spectral ratios for S-wave coda from aftershock recordings, and it was revealed that the basin sediments stronglyamplified the long-period components of the ground motions of the mainshock and large-magnitude aftershocks.
The 2015 Mw 7.8 Gorkha, Nepal, earthquake occurred at 11:56 local time (UTC + 05:45) on April 25, and several moderate- to large-magnitude aftershocks followed the event. The mainshock caused the widespread damage of buildings and resulted in the loss of more than 8600 human lives in cities and villages; approximately 20 % of the casualties were from various sites located in the Kathmandu basin (Ministry of Home Affairs, Government of Nepal 2015). In addition, a major aftershock of Mw 7.3 on May 12 resulted in over 200 casualties and additional building damage, mostly in the epicentral area. A nationwide permanent monitoring network of strong ground-motion stations does not yet exist in Nepal (as of January 2016). Strong ground motions recorded at Kantipath (KATNP), Kathmandu
The magnitudes of the events range from Mw 5.0 to 7.8, and their epicentral distances range from approximately 23 to 84 km. All of these events were shallow-focus events with focal depths of 10–23 km that occurred on low-angle reverse faults with dips in the north-northeast direction.



Event locations and magnitudes:

ID	Local origin time	Latitude	Longitude	Depth (km)	Magnitude
1	April 25, 2015, 11:56	28.2305	84.7314	8.22	7.8
2	April 25, 2015, 12:30	28.2244	84.8216	10	6.6
3	April 25, 2015, 12:41	27.8822	85.7505	10	5.5
4	April 25, 2015, 14:40	27.5866	85.5058	10	5.3
5	April 26, 2015, 05:01	27.7993	84.8715	13.61	5.1
6	April 26, 2015, 12:54	27.7711	86.0173	22.91	6.7
7	April 26, 2015, 22:11	27.8297	85.865	14	5.0
8	May 12, 2015, 12:50	27.8087	86.0655	15	7.3
9	May 12, 2015, 13:21	27.625	86.1617	15	6.3

Long-period ground-motion intensities at the KATNP site:

ID	Magnitude	Hypocentral distance (km)	Observed long-period intensity	Predicted long-period intensity	Observed peak absolute velocity response (cm/s)	Median predicted absolute velocity response (cm/s)
1	7.8	81.62	4	3	394.4	88.3
2	6.6	75.34	3	2	55.7	34.1
3	5.5	47.78	0	1	1.7	5.4
4	5.3	25.35	0	1	2.9	6.9
5	5.1	46.82	0	0	3.6	2.3

ID	Magnitude	Hypocentral distance (km)	Observed long-period intensity	Predicted long-period intensity	Observed peak absolute velocity response (cm/s)	Median predicted absolute velocity response (cm/s)
6	6.7	72.98	2	2	36.8	43.8
7	5.0	57.31	0	0	2.9	1.5
8	7.3	76.02	3	2	62.6	41.5
9	6.3	85.18	1	2	9.7	15.5

Conclusion:

- Strong ground motions from the Mw 7.8 Gorkha earthquake and its eight aftershocks recorded by a strong-motion seismograph at the KATNP site were analyzed to understand the characteristics of strong ground motions and site effects.
- The GMPEs developed for crustal and interplate events in Japan were found to generally well describe the observed PGAs and PGVs at the Kantipath site, except for the PGA of the main shock.
- A comparison of the observed response spectra with those from the GMPEs indicated that the ground motions at the KATNP site were strongly influenced by the local site condition at long periods; hence, appropriate deep soil correction factors for the Kathmandu basin must be developed.
- An indirect analysis of the recordings for soil nonlinearity suggested that the KATNP site experienced a substantial reduction in short-period ground motions during the main shock because of the nonlinear site response. To fully explain this nonlinearity, a broadband ground-motion simulation considering details regarding the surface soil layering, propagation path, and rupture characteristics of the earthquake is necessary.
- A 1D velocity structure model was developed for the deep sediments beneath the recording station based on the *H*/*V* spectral ratios for the S-wave coda.
- A simple validation of the model by waveform simulations demonstrated that the proposed velocity model is able to explain the observed large-amplitude velocity waveforms at the peak periods of approximately 4–5 s for the main shock.
- Thus, we conclude that the deep sediments beneath the recording station at the KATNP site strongly amplified the long-period components of the ground motions during the main shock and its large aftershocks.