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Geotechnical Earthquake Engineering

ASSIGNMENT NO. 2:

Study of Significant Earthquakes in Nepal

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Nepal is an earthquake and disaster prone country. Landslides, epidemics, fire hazards triggered by earthquake causes considerable losses of human lives and property. The main reason behind the earthquake in Nepal is the Indian plate colliding with the Eurasian plate. The movement is continuously occurring at the rate of 4-5 cm per year and the only way to release this energy is through the earthquakes. The upward climb of Everest and its sister mountains is accompanied by numerous tremors. Moreover, the remnants of a prehistoric lake, a 300 meter-deep layer of black clay, lies underneath the Kathmandu Valley. This augments the damage caused by severe earthquakes. Based on the data available from the Department of Mines and Geology, CBS (1998) concludes that earthquakes of more than or equal to 5.0 on the Richter scale have occurred at least once every year in Nepal since 1987, with the exception of 1989 and 1992 when no such events were recorded.

Almost the whole of the county falls in high intensity scale of MMI IX and X for the generally accepted recurrence period.

Timeline of Earthquakes in Nepal

S.N.	Year of Occurrence	Magnitude on Richter Scale	Place (Latitude/Longitude)	Fatalities	Important Remarks
1.	1255 AD	7.7	Kathmandu (27.7/85.3)	1/3rd population of Kathmandu Valley was killed including Abhaya Malla, king of Kathmandu Valley. Numerous temples and buildings were also completely destroyed.	
2.	1260 AD	7.1	Sagarmatha (27.1/86.8)	Exact no. of fatalities not known but there was a heavy loss of lives which was followed by epidemic and famine.	
3.	1408 AD	8.2	Near Nepal-Tibet Border, Bagmati Zone (27.9/86.0)	Temple of Rato Machhindranath was completely destroyed. Many other buildings were also destroyed.	

S.N.	Year of Occurrence	Magnitude on Richter Scale	Place (Latitude/Longitude)	Fatalities	Important Remarks
4.	1681 AD	8.0	Northern Koshi Zone (27.6/87.1)	Heavy loss of temples and buildings.	Very little information available.
5.	1767 AD	7.9	Northern Bagmati Zone (28.0/85.5)	No written evidence found to document the human & property losses.	21 aftershocks were felt in span of 24 hrs.
6.	1833 AD	8.0	Kathmandu/Bihar (27.9/85.5)	The tower of Dharahara was also severely damaged. The towns of Thimi and Bhaktapur bore the brunt of the disaster. A total of 4,214 houses were destroyed then.	
7.	1869 AD	6.5	Kathmandu (27.7/85.3)	The earthquake destroyed towns and devastated districts.	The acceleration of the ground in these cases exceeds 5 feet per sec.
8.	1934 AD	8.4	Nepal-Bihar earthquake (26.77/86.67)	Casualty figures were the highest for any recorded earthquake in the history of Nepal. In total, approximately 10,500 people lost their lives, a total of 1,26,355 houses were severely damaged and around 80,893 buildings were completely destroyed.	The total money spent from the earthquake relief fund was Rs 2,06,500 in the Kathmandu valley only.

S.N.	Year of Occurrence	Magnitude on Richter Scale	Place (Latitude/Longitude)	Fatalities	Important Remarks
9.	1966 AD	6.1	Nepal/India Border (29.554/80.854)	Due to the dense population and weak building construction in the epicentral area, 80 persons were killed and 5,000 houses were destroyed.	
10.	1980 AD	6.5	Nepal/Pithoragarh (29.59/81.09)	The earthquake caused $245 million damage	
11.	1988 AD	6.9	Nepal/Bihar (26.77/86.61)	There were 721 deaths, while 6,553 people were injured. A total of 64,174 private buildings, 468 public houses and 790 government buildings were damaged. The total direct loss amounted to Rs 5 billion.	
12.	1993 AD	5.1	Central and Mid western region	One person was killed leaving 11 injured. 72 houses were destroyed.	
13.	2011 AD	6.9	Kanchanjunga Conservation Area (27.33/88.62)	At least 111 people were killed in the earthquake. Most people were from Sikkim.	
14.	April 25, 2015 AD	7.8	Gorkha (28.19/84.87)	About 9,000 people were killed, many thousands more were injured, and more than 600,000 structures in Kathmandu and other nearby towns were either	

				damaged or destroyed	

Among the many earthquakes that took place in Nepal, the most significant and talked ones in our generation are 1934 AD and the recent one of 2015 AD.

1934 AD Earthquake:

The 1934 earthquake of Nepal (1990 B.S.) with the epicenter about 10km south of Mount Everest measured 8.4 Richter scale and it killed approximately 10,500 people. The total population in the area then was low.

One noteworthy phenomenon of this earthquake was that sand and water vents appeared throughout the central vents of the earthquake area. The ground around these sand fissures subsided, causing more damage. Extensive liquefaction of the ground took place over a length of 300 km (called the slump belt) during the 1934 Earthquake.

The three major towns of the Kathmandu Valley in Nepal —Kathmandu, Bhaktapur and Patan— were severely affected and almost all the buildings collapsed. Large cracks appeared in the ground and several roads were damaged in Kathmandu; however, the temple of Pashupatinath, the guardian deity of Nepal, escaped any damage.

A 1935 work by Major General Brahma Shamsher documenting the event, *Nepalko Maha Bhukampa 1990*, stated that this was Nepal's most destructive earthquake in living memory.

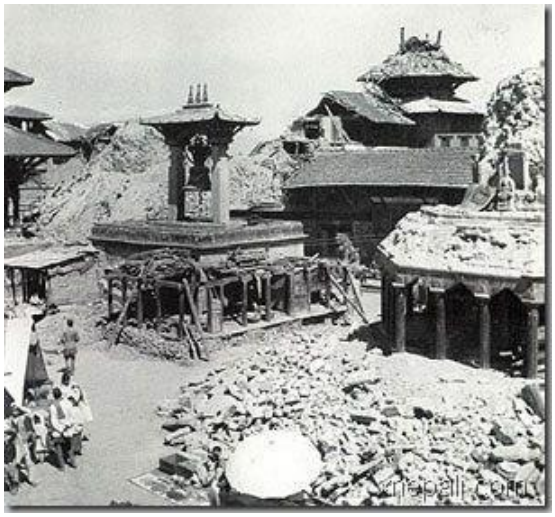

Fig: Temples destroyed in 1934 Earthquake

(*Source: https://xnepali.net/earthquake-history-of-nepal/*)

2015 AD Earthquake:

The devastating earthquake that hit the country with the magnitude of 7.8 Richter scale with its epicenter at Mandre, Barpak VDC-02, Gorkha have caused an inconceivable loss of lives and properties. The fatality was further triggered by its aftershock chiefly of 26 April (6.7 Magnitude) and 12 May (7.3 Magnitude).

(Source: https://www.britannica.com/topic/Nepal-earthquake-of-2015)

The earthquake and its aftershock were the results of thrust faulting (i.e. compression driven fracturing). The earthquake relieved compressional pressure between the Eurasian plates and the Indian plate. Subduction in the Himalayas is occurring at the rate of 4-5 cm per year which adds more than 1 cm to height of the Himalayan Mountains every year.

The deaths of approximately 9,000 people were confirmed including the people nearby parts of India, China and Bangladesh. 16,800 people were injured and 2.8 million people were displaced.

The earthquake triggered landslides at different rural places and densely populated areas of Kathmandu. Buildings enlisted in the UNESCO world heritage were destroyed. Inside Kathmandu, bricks and other debris from collapsed and partially collapsed buildings, which included parts of the famous Taleju Temple and the entire nine-story Dharahara Tower, filled the streets. The earthquake also triggered an avalanche on Mount Everest that killed at least 19 climbers and stranded hundreds more at Everest Base Camp and at camps higher up the mountain.

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