The Clarion Volume 6 Number 1 (2017) PP 119-120

The Clarion

International Multidisciplinary Journal

ISSN : 2277-1697

General article : views and analysis

Dams - not a threat but a necessity for modern India.

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Himalayas the mighty mountain ranges span almost the entire breadth of 2500km of the Indian subcontinent. They are examples of mountain ranges formed by two continental plate collision between Indian plate and the Eurasian plate. Because of this typical geography Himalayas are home to frequent seismic activity.

Himalayas are also blessed with some mighty rivers with great power potential trapped within them. Any attempt to develop these natural resources into a major energy source in form of Hydroelectric projects is a challenge. If not tapped, the renewable form of energy will be getting wasted every year without providing any benefits to citizens of India specially the locals in the nearby areas. In the face of drought and flood conditions faced by different parts of the country along with severe power shortages constantly faced, construction of Dams can come as great relief to the public. One question which is often raised amidst all this is- **are the Dams built in the Himalayas worth building considering the risks involved.**

When it comes to water management on a large scale, agrarian country like India needs Dams for water storage in adverse times considering the situation faced in the past few years. So building of dams will be a big step towards mitigating drought and facilitating flood control measures. It is also a fact that earthquakes don't kill but the randomly constructed structures which do not follow the stringent IS codes laid down for aseismic design of structures are the major cause of destruction. Earthquakes can't be controlled but what can be done is to design earthquake resistant structures.

In recent times questions have been raised on construction of dams in seismically active Himalayan terrain. If designed with great care, taking into consideration the seismicity factors during design and construction of these structures, they perform safely and contribute to the economy of the region. Countries like China and Japan with very high seismicity incidences have successfully built some biggest dams of the world which are functioning safely. In the Indian context also, this fact is strongly supported by the performance of the hydro projects in high seismicity region of the Himalayas which have withstood some of the big shocks felt in the last decade in the Himalayan belt ranging from Jammu and Kashmir to the North Eastern region.

The **2005 Kashmir earthquake** of magnitude 7.6 occurred on 8 October in the Pakistani territory of Azad Kashmir. It was centered 19 km northeast of the city of Muzaffarabad, (epicentre 34.45°N 73.65°E) and also affected the Indian state of Jammu and Kashmir. Muzaffarabad, was hardest hit in terms of casualties and destruction.

On Indian side widespread destruction was seen in the Baramulla District. However, the operating hydropower station of **Uri I** of NHPC at a distance of only about **53km** from the epicentre withstood the earthquake without any damage to the structure or its functioning. This only proves that proper designing and construction can withstand any earthquake without causing any harm to people.

The **18th Sep. 2011 Sikkim Nepal earthquake** of magnitude 6.8 rocked the Northeastern state of Sikkim (epicentre 27.7^0 N 88.08^0E). The effect of this earthquake was widespread with tremors felt as far as West Bengal, Assam, Bihar and Delhi. Buildings, monasteries and roads collapsed due to this event on a large scale.

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DOI number: 10.5958/2277-937X.2017.00020.X

Post earthquake NHPC assessed the impact of this earthquake on number of its hydroprojects operating in the state. Teams from institutes and government bodies like IIT-Kanpur, CWPRS also went independently to assess the onsite damage. The projects were **TeestaV** HEP (56km from epicentre of the earthquake), **Rangit Power station** (53km from epicentre), **Teesta Low dam** III (82km from epicentre), **Teesta Low dam** IV (88km from epicentre). All the projects performed well during the earthquake and no damage was observed. With some of the HEP's operating so close to the epicentre, the robust earthquake resistant design of these structures once again comes into play.

The **25th April 2015 Nepal earthquake** of magnitude 7.8 which struck around 81km from Kathmandu occurred due to the collision tectonics of two continental plates the Indian Plate and the Eurasian Plate. Widespread damage was reported from Nepal including states of Bihar and Bengal of neighbouring India. Landslides and Himalayan avalanches were triggered due to this event. Many building and airport in the capital city of Kathmandu were destroyed.

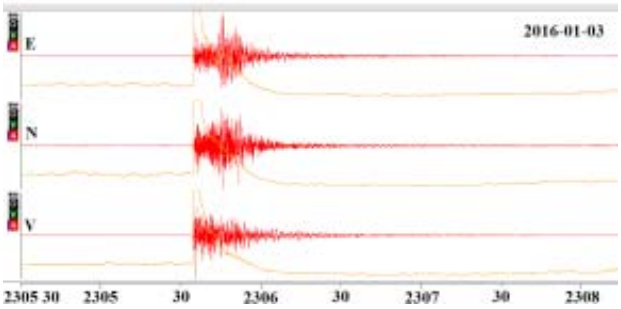
Installed accelerograph

This event had been recorded by accelerographs installed at NHPC power stations ranging from the state of Sikkim to projects as far as in Jammu and Kashmir. Four power stations located in Sikkim which were closest to this event operated smoothly without any damage.

Accelerograph installed at Uri-II project, J&K

With the dawn of the new year, on 3th Jan. 2016 Tamenglang district of Manipur was rocked by an earthquake of magnitude 6.7 (epicentre 24.8N, 93.5E). Damage to property and loss of life was reported from the area. One of the nearest operating power station of NHPC at Loktak was merely at a distance of 53 km from the epicentre and again the project performed well without any damage.

In order to have close monitoring and better control, NHPC has setup a one of its kind **Real Time Seismic Data Center** at its Corporate Office. Accelerographs installed at all these Power Stations are connected online to this data center. This is a big step towards strengthening the seismic monitoring of all its projects.



Acceleration data of Manipur Earthquake recorded at Loktak Power station (PGA= .0272g, epicentral distance 53.5km)

With this new initiative NHPC was able to collect some valuable acceleration data for these events at its power stations. On performing a comparative study it is found that the **actual value of PGA recorded at all the power stations is much lower than the computed values of PGA derived after application of attenuation laws like those of Abrahamson & Litehiser (1989) and Campbell, Boore & Joyner** (1981) which shows that all NHPC structures are over safe against any seismic activity.

From above cited examples, it can definitely be stated that with competent and careful selection of seismic design parameters for design of structures like dam and its components, a safe performing structure can be built. From the recent examples mentioned above, it shows that design and construction of hydro projects are so far safe in India. In future also similar approach shall be adopted by all developers, so that people can get only benefits without any single cause of harm. In India it is mandatory to get the seismic design parameters of hydro projects approved from **National Committee on Seismic Design Parameters** a high level interdisciplinary official body set up by GoI. The site specific seismic design studies of hydro projects are to be approved from NCSDP before the project clearance. By generating public awareness about the actual science and engineering involved in construction of hydro projects, the Nation can look forward to clean and safe renewable source of energy & water management.