Needs of Early Earthquake Warning System in North-Eastern Region of India

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***Abstract*:** In this paper, the seismic hazard regions of the world as well as the seismic regions of India has been focused. The early Earthquake Warning system and the use of MEMS accelerometer for EEW system have also been explained. Finally, an analysis of some recent occurrence of earthquake in north eastern region of India has been explained.

key words *- Earthquake, EEW system, MEMS Accelerometer.*

I. INTRODUCTION

In spite of the scientific and technological development, one can't ignore the natural laws. Nature has demarcated to the scientific community to think or predict some natural phenomenon which can be considered as a natural warning. One of the natural warning is Earthquake which is the most damaging natural activity caused due to the sudden release of energy in the earth's crust. Earthquake generates seismic waves such as longitudinal wave, shear-wave and surface wave. Out of these seismic waves, surface waves and shear-wave are most destructive, but these waves are slower than longitudinal wave. The longitudinal wave and the shear-wave are also known as P-wave and S-wave. Geller R.J. et al [1] has been reported that, it is impossible to predict earthquake. Many scholars have been searching the reliable predictable indication for earthquake since the civilized period of the society, but it is found to be impossible till today [2-4].

Due to the modernization of cities, earthquake offers serious risk to human lives. So it is necessary to develop some earthquake prediction system which can save many lives. Early Earthquake Warning (EEW) System is a major technological development which can minimize the earthquake hazards. It has been found that the 'Early Warning' term was proposed by Cooper [5] in 1868. The modern EEW system is based on the concept of unimplemented idea of Cooper. Another important idea of EEW which is related to the speed and the destructive nature of seismic waves has also been forwarded. Many researcher have used many devices such as accelerometer, vibrometer etc to detect the P-wave. Most recently MEMS (Micro-Electro-Mechanical-System) Accelerometer is used in EEW system to detect the seismic waves. It has been reported that the uses of MEMS Accelerometer to detect the earthquake has been focused by S. Kalita in 2013 [6]. Many countries have already implemented EEW system for rectifying the earthquake hazards [7]. It has been found that Japan is the only country in the world which has nation-wide EEW system.

II. SEISMIC HAZARD REGIONS OF THE WORLD

After the successful completion of the project of Global Seismic Hazard Assessment Program (GSHAP), D. Giardini et al. put forward a global seismic hazard map [8], which shows all the seismic zones of the world. It also represents seismic hazards as peak ground acceleration (pga) and the 10% possibility of ground motion for next 50 years. The Global Seismic Hazard map shows all the major seismic zones such as Alaska, San Francisco, western part of Mexico, western part of South America, Middle East, Himalayan Ranges, Indonesia, Japan, and New Zealand etc.

III. SEISMIC REGIONS OF INDIA

Due to the various past seismic activities in the Indian Plate, it is necessary to study the seismic regions in India which helps earthquake engineering and construction engineering. The seismic zone of India can be divided into four zones (Zone 2, 3, 4 and 5). [9-11]. It has been found that the zone 5 is the highest risk zone which includes, the state of Kashmir, the western and central Himalayas, the North-East Indian region and the Rann of Kutch. Thereafter, Zone 4 is found as the high damage risk zone. The Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under moderate damage risk zone which is classified as zone 3. Zone 2 is known as low damage risk zone.

IV. EARLY EARTHQUAKE WARNING (EEW) SYSTEM

Early earthquake warning (EEW) is a useful system to the human being, which can warn before the arrival of earthquake. As reported earlier, Cooper proposed the 'Early Warning' for first time in 1868. Now a day's several EEW system is based on the Cooper's idea [5]. It has been

reported that Japan Railway system implemented seismometer along the tracks for reducing the accidents at the time of earthquake in 1960. In 1984 Nakamura, Y. put forward an earthquake warning system, used to detect the earthquake more precisely [12]. In this system Nakamura used network and front detection technique.

It has been reported that Allen et.al in 2009 has discussed the various concepts of EEW [7]. The present concepts of most EEW's are based on the speed and the destructive nature of the seismic waves as the speed and the destructive nature of the seismic waves are different. P-wave travels faster than the S-wave. On the other hand the destructive force of P-wave is smaller than the S-wave. Regions like Marmara region, Turkey [13], Southern Apennines, Italy [14] and Taiwan [15] implements EEW system based on this concept. [Figure-1] shows the seismic wave concept of EEW system. In this figure the inclined lines represents s-wave and p-wave respectively. The vertical dotted line represents the position of the EEW system and the horizontal dotted lines represent the time of arrival of the seismic waves at the EEW system. This figure explains that the p-wave traveler faster than the s-wave and the p-wave reaches the EEW system position before the s-wave. So, the EEW system generates alarm when the p-wave magnitude is greater than some threshold values.

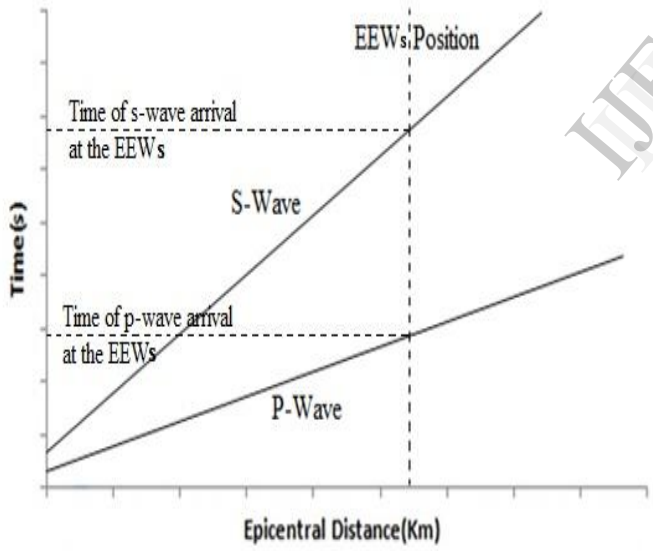

Figure-1: Seismic Wave Concept of EEW System.

Ye Ke et.al has discussed the design and research of an Earthquake Early Warning System for railways which was very important for disaster monitoring technology in 2011 [16]. In the same year E. Hohnecker et.al also put forward some ideas of Earthquake Early Warning System for railways [17]. Recently Hloupis, G et.al used wavelet based algorithm for local magnitude estimation of Earthquake oriented to Early Warning [18].

V. EEW USING MEMS ACCELEROMETER

MEMS Accelerometer is a device which can detect the acceleration, shock etc. It has many applications such as Image Rotation in Cell Phones, Free fall detection (HDD protection), gaming, Image stabilization in Digital still Cameras, Realistic Motion etc. Recently many researcher uses MEMS Accelerometer for detecting the earthquake. In 2003 Holland, A. used MEMS Accelerometer to record the earthquake data [19]. It has been reported that Horiuchi, S. et.al introduced MEMS Sensors for home seismometer detect the earthquake and give early warning. This seismometer was based on Seismic Wave concept [20].

Huayin Zheng et.al also designed some home based wireless earthquake early warning system using MEMS Accelerometer in 2011. In this system the author used MMA7260Q MEMS Accelerometer, which has the range of ± 1.5g [21].

VI. NEEDS OF EEW SYSTEM FOR NORTH EASTERN ZONE OF INDIA

North Eastern region of India includes eight states of India. Some of the important cities like Guwahati, Shilong etc. are situated in this region, which are the gateway to the ASEAN countries for rest of the Indian states. Around 45 million people lives in this zone. This region is located at the zone 5, which is the highest risk zone for earthquake. Hence the damage of life and properties of this region due to earthquake will be definitely increased. In this region, Many damages have been reported so far due to the earthquake [22]. Some of the major earthquakes are listed below.

Date	Event	Time	Magnitude
12 June 1897	Assam	17:11	8.7
15 Aug 1950	Assam	19:31	8.5
18 Sep 2011	Sikkim	18:10	6.9

The [figure-2] gives the information of increasing the number of earthquake during the year 2006 and 2013. Here x-axis represents the years and the y-axis represents the number of occurrence of earthquake.

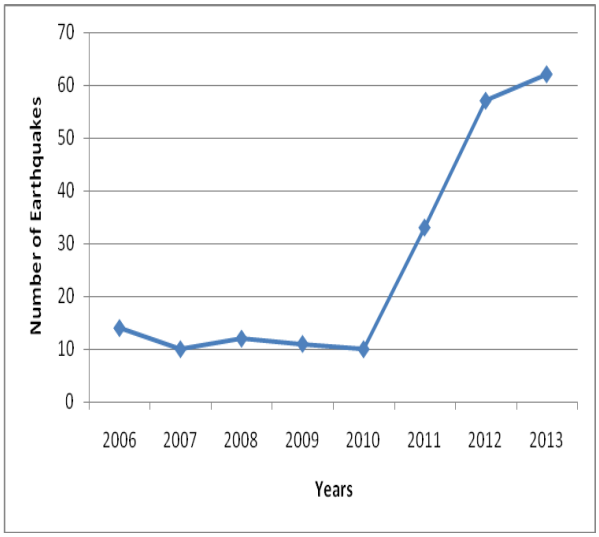

Figure-2

The [figure-3] explains the occurrence of earthquake for the year 2013 from the months of January to October and [figure-4] shows the occurrence of earthquake for 2012 from the months January to December

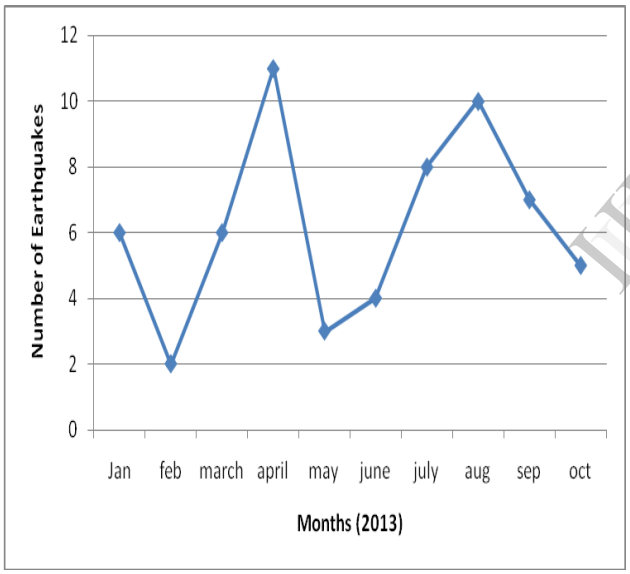

Figure-3

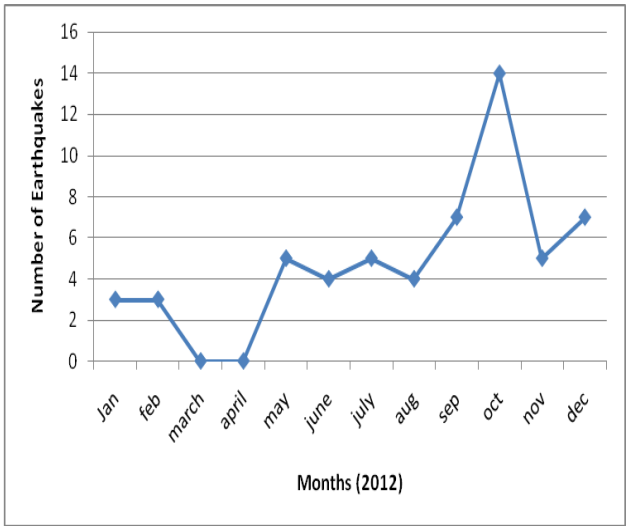

Figure-4

From the above Figures [figure-2, 3 and 4] it is clear that the existence of earth quakes are randomly occurred in this region and hence high level research is necessary for Early Earthquake Warning system.

CONCLUSION

Through this article, some ideas on EEW system have been discussed. In addition to that some study on recent occurrences of earthquake in North-Eastern region of India is done and from the study we can conclude that the earthquake occurrence in this region increased day by day and needs Early Earthquake Warning system to prevent the loss of life.

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