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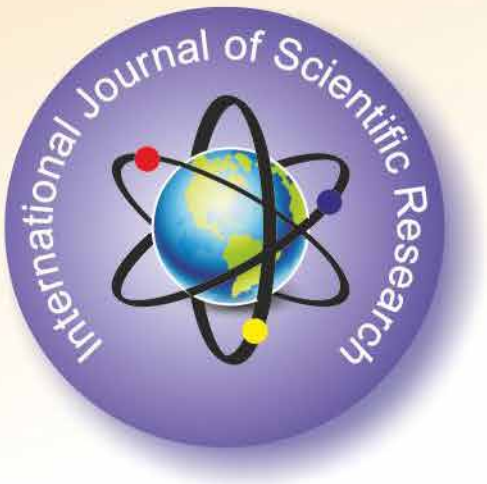

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Research Paper

The Killari 1993 Intracratonic Earthquake- a Comparative Study

Environment

KEYWORDS : Intracratonic/Intraplate, Unpredictability, Stable Continental Region, Protocol.

S.S. Patil, Department of Environmental Science Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

K.L. Karkare Department of Environmental Science Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

I.B. Ghorade Department of Environmental Science Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

ABSTRACT

An earthquake is the result of the continuous cycle of stress accumulation and strain release along the fault and seismogenic structures in the earth's crust. The relative rarity and unpredictability in occurrence of earthquake make planning difficult, it encounters barriers in inertia, self interest and long term cost. The Killari type intraplate/intracratonic earthquake is representative of the type of infrequent, but devastating moderate magnitude that occurred in a low seismicity region on a shallow unknown fault [Shedlock and Pasikar, 1994] system.

Introduction:-

An earthquake is the result of the continuous cycle of stress accumulation and strain release along the fault and seismogenic structures in the earth's crust. The relative rarity and unpredictability in occurrence of earthquake make planning difficult, it encounters barriers in inertia, self interest and long term cost. The present study compares the earthquake Killari 1993 [India] and Kobe earthquake disaster 1995 [Japan] though these disasters represent different cultural and tectonic setting but the lessons can be applied for all cultures.

Material and Methods

During the present research work, along with social worker we made daily visits to Killari and villages around it over a week. The first day we visited to Killari grampanchyat officials, spoke about the nature and purpose of the visit. During the subsequent visits, the visit was made to those families who lost their relatives, property, were themselves affected, were present through emergency operation and people who happened to be outside killari earthquake affected area. Data relating to Killari earthquake 1993 [India] and Kobe earthquake 1995 [Japan] is also extracted from research Journals, articles, books, and by using google.com search engine.

Results & Discussion

Sr. No.	Variable	Killari earthquake 1993, India	Kobe earthquake 1995, Japan
1	Geographic Coordinates	18^0.2 N; 76^0. 4E, Near Killari	34^0N; 135^0E
2	Type of Earthquake	Intraplate	Inland shallow Earthquake
3	Seismic Historicity	No Known history of past Earthquake	6.1 R. Earthquake in 1916
4	Frequency	Infrequent	Tend to occur frequently
5	Predisposing factors	Terna Reservoir [?]	3 or 4 plates overlap
6	Foreshocks	125 felt, very active swarms	4 Foreshocks; Mj 3.7
7	Main shock duration	5 seconds	20 Seconds
8	Aftershocks	Felt; about 103	Appr. 50 of Mj. 4.0 or more
9	Focal depth	6.8 km.; shallow focus	16km; shallow focus
10	Fault system	Shallow unknown/ Transform	Nojima Fault
11	Epicentre	About 12 km.; West of Killari	20 miles south of kobe
12	Magnitude	Mw=6.36 [USGS]	Mw= 7.5JMA, or on 6.9 R.
13	Intensity	Meso. Area Intensity VII-IX	7-Shindo Magnitude
14	Geology	Deccan Trap of Peninsular India	The most unstable Region
15	Liquefaction	Incidences not reported	Wide spread lieuefaction
16	Setting	Traditional Rural setting	Urban
17	Time of the occurrence	3.46 a.m. [Local Time]	5.46 a.m. [Local Time]
18	Engineered structures	Relatively Scarce	More than 17,000
19	Non Engineering structures	Stone and Mud houses	Traditional Timber Houses
20	Building codes Enforcement	Little consideration of seismic design	Seismic code after 1981
21	Fire	Incidences not reported	More than 300 fires Registered
22	Infrastructure	Insignificant damage reported	Hanshin expressway collasped
23	Surprises	The Region considered as aseismic	Right lateral-strike-slip Fault
24	Strategic preparedness	None	
25	Forceast	Not Predicted	Not Predicted
26	Cause of Death, Injury	Collapse of Mud-stone houses	Not Predicted
27	Economic losses	Rs. 12000 million	Collapse of Houses, Buildings, fires, etc.
28	Emergency Response	Immediate Search & Rescue	Yen 6.9 trillion
29	Recovery	MEERP	Slow and confused
30	Research and Development	Seismograph installed at Latur	Slow to Recover
			A renewed effort

MEERP: Maharashtra Earthquake Engineering Research Project

Except for the precursory activity in 1992, the Killari area is not known to have had prior earthquake during the historic period. In the light of above fact that Killari was considered as aseismic.

Frequency: There is no figure showing the average number of earthquakes per experienced year in Japan, but the country subjected to regular seismic activity and can be anything upto 1500 earthquakes recorded in a given year.

The Killari type intraplate/intracratonic earthquake is representative of the type of infrequent, but devastating moderate magnitude that occurred in a low seismicity region on a shallow unknown fault [Shedlock and Pasikar, 1994] system. The frequency of intracratonic earthquake is less than 0.5% [Smith, 1991] of the global seismicity hence they can take region's administration and people by surprise. The intracratonic seismicity in India is well represented in number and size [Runn of Kutch, Gujrat, 1819; Bellary, Karnatake, 1843; Koyana, Maharashtra, 1967] [Jain et.al; 1994]. It was a surprise not only

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because it occurred at a great distance from the well known active Himalayan seismic belt; also it occurred in region that was declared least hazardous [zone '0'] on National earthquake hazard map.

Pre-disposing factors: In case of Kobe earthquake, literature survey shows no artificial pre-disposing factors.

The Killari earthquake epicenter lies about 10 km from the lower Terna reservoir. The reservoir level was low at the time of mainshock which is consistent with the expected negative effect of the loading by the reservoir on an underlying thrust fault [Smith, 1991].

Foreshocks: Kobe earthquake was preceded by four foreshocks, the largest being of Mj 3.7. A very active swarms between August and October 1992 were felt in Killari and surrounding area. Short term prediction on the basis of foreshocks is not always reliable. Neither of earthquake was predicted and population warned.

Mainshock Duration: The main shock lasted for 5 seconds in Killari earthquake and in case of Kobe it was 20 seconds.

Aftershocks: '50' Aftershocks in case of Kobe and Killari '103' in case of Aftershocks are dangerous because their number and location of are random, usually unpredictable. Sometime they do little damage but keep a stricken population in a state of fear and occasionally these aftershocks are the major earthquake in their own right.

Focal depth
Earthquake occurs at a range of depths. Killari [6.8 km] and Kobe [13.3 km] both are shallow focus earthquakes. Shallow focus earthquake are more common and are extremely damaging because of their close proximity to the earth's surface.

Engineered Structure: In Kobe city Some 75,000 building [Estimate vary] were destroyed. Engineered structures were relatively scarce in the Killari area due to the traditional rural setting.

'Building Code Enforcement': The strict enforcement of building code resulted in that the pre-1981 buildings were left in ruins while the post-1981 building held up relatively well.

Killari lacked a known history of past earthquake, hence there had been little consideration of seismic design, and the severity of damage was primarily attributed to the unreinforced Masonary construction.

Fire: The collapse of buildings was followed by the ignition of over 300 fires within minutes of the Kabe earthquake. These fires were caused by ruptured gas lines which were sparked by electrical shot-circuits, broken water pipes, wooden buildings, destroying at least 7,500 homes, causing 500 death and More than 13,00,000 Sq. meters were burnt.

There are no reported incidences of fire following the Killari earthquake. As the area is typical of rural setting.

Strategic Preparedness: Japan has such considerable experience with a earthquake disasters management. Kobe was considered seismically safe. Hence earthquake disaster preparedness did not match Japan's technological superiority and economic standing.

The Killari was considered aseismic area though people in the area felt the foreshocks nearly one year prior to the mainshock. But foreshocks are not indicative of mainshock. Hence there was no earthquake disaster preparedness. The earthquake took people and government by surprise.

Cause of Death: More than 5000 people were killed [estimate vary] as a result of Kobe earthquake. Approximately 90% of the dead people were killed by the collapse of traditional wooden homes and building constructed before 1981 [Otani, 1999].

Kobe Earthquake: Causes of death

Cause	Number	%
Collapse of Building	4816	87.6
Fire	570	10.4
Highways	17	0.3
Landslide	11	0.2
Overturned Furnitures	65	1.2
Total	5479	100.0

Killari earthquake killed around 8000 [estimate vary] people. The primary death cause is due to the collapse of traditional stone and mud [Unreinforced] buildings in the area [Jain, et.al; 1996].

Deaths due to fire, highway collaps and landslides are not reported.

Economic losses
Total economic losses due to Kobe earthquake disaster amounts to $ 100 billion. The loss is primarily made up by damage to buildings residential houses, infrastructural [Rs. 4000 million] facilities of various kinds and small portion of agriculture and allied activities. Economic losses in case of Killari earthquake is Rs. 1,2000 millions, is dominated by agricultural and allied activities and a very less of building, residential houses and infrastructural facilities damage. The comparison shows that earthquake disaster is related to the setting in which they occur.

Preparedness
The unreinforced masonry homes that dominated Killari and around area heavy are well known for their vulnerability to earthquake ground shaking. Due to the region's low seismisity, the potential risk was considered acceptable and they were not designed to withstand the level of strong ground shaking that occurred.

The area has no known seismic history and was considered as a aseismic. There did not exist any earthquake preparedness. The people of Killari and around area experienced foreshocks of varying magnitude for almost one year prior to main shock. Some people put up 'tinshed' attached to their main houses where they slept, other logded complains were with the government authority to institute an effective anti earthquake measures but no actions were taken. A few people slept on the farm house as a preventive measures.

Emergency response
Of all the villages devastated by the Killari earthquake, only the village of Killari had a wireless connection with the district police headquarters at Latur. Immediately, about 20 policemen stationed at Ausa taluka headquarter [20 kms away from Killari] were rushed to devastation site, district level administrators arriving later at disaster scene. In the immediate post impact period search and rescue [SAR] operation were carried out by the surving uninjured family and community members and a limite police force. By early next morning, the Indian army took over the task of providing emergency relief, and search and rescue [SAR] operation. The civil administration took 2-4 days to effectively organize the rescue and relief operation. Many Non Governmental Organisations [NGOs] also provided humanitarian assistance.

Mass cremations that were held on the first two days after the earthquake were done without adequate record keeping. This led to confusion about the actual number of deaths. At one time, the newspapers were reporting up to 30000 deaths. Later it was discovered that about 9000 fatalities actually occurred.

More than 5,000 people were killed [Estimate vary] as a result of Kobe earthquake. Approximately 90% of these deaths were due to the collapse of traditional wooden houses and building constructed before the collapse [Otan, 1999].

As Kobe was considered seismically safe hence, the level of

earthquake preparedness did not match Japan's technological superiority and economic power. There was no immediate response by authorities. The Self Defense Forces [SDF] took five hours to respond to and two days to arrive in Kobe.

The Kobe response management appeared slow and less than optimal in performance. Anecdotally, [Biema, 1995] provides example of delay immediately after the quake, Kobe authorities failed to cordon off mainroad for official use, the delay of police and fire vehicle undoubtedly raised death toll. For nearly four hours, the governor of the Hyogo Prefecture, which includes Kobe, neglected to make the necessary request for aid to the national armed forces.

Media found that the central government had difficulty in organizing a response, for example, conventional Japanese bottom-up-decision-making style impedes central executive decision and require more time in which to arrive at decision. Tazaki [1995] noted that in Japan each ministry and agency individually deals with the problems to build an external consensus.

By [Hofsted, 1980] indicators, Japanese response may be reduced by the need or more certainity in the situation and by the need for strong leadership from the established political and community organization. Casse [1982] noted that Japanese organization tend towards a step-by-step consensus group decision making. Given these aspects, Japanese bureaucrats are likely to wait until consensus is achieved. Such behaviour is likely to slow down emergency response management and create consequent time lags [Robert, 1995].

Kreps [1978] noted that the centralized nature of Japan's organization is likely to be more routine, but less adoptive. The bottom-up-decision making process and need to follow proper protocol are both likely to slow down decision making. Stallings [1978] determined that professional response organizations may be less adaptive when responding to crisis and disaster situation because of day to day structure of the work and organisation involved.

Disaster victims were put in schools, town halls, open parks, etc. and were forced to live in some cases for long periods, in overcrowded, unsanitary conditions. Food, Blankets, Medical supplies and water were for the first days were in short supply.

Around 1.5 million volunteer responded rapidly by taking on a considerable portion of relief activity [Masako, 2000]. Much of this was co-ordinated by the volunteers themselves through organizations such as the 'volunteers centre' which were established in each ward of Kobe, i.e; volunteer's committee in Ashiya and the volunteer's headquarter in Takarazuka.

Recovery

Following Kobe earthquake recovery/restoration of lifelines and other urban functions was accomplished relatively quickly viz electricity, 6 days; telephone, 14 days; gas, 84 days; water, 90 days; severs, 93 days; but the construction of industry and housing took longer.

By January 24th, 1995; 589 evacuation shelters [transit shelters] were set up to house 2,36,899 people. By January 1999, 1,34,000 houses have been constructed, yet many continue to live in temporary housing. Realising this Japanese government established the "Kobe Housing Transition Promotion Centre" and the "post quake citizen support services" to help heal to the emotional scars left by the great Hanshin [Kobe] earthquake [1995]. By February [1996] all schools reopened displayed vital role in the psychological recovery of city's youth. By the August of the same year [1996] the railways was fully functional, 1995 was called the "first year of "volunteerism" because 1.13 billion volunteers from all over Japan arrived to help rebuilt Kobe.

A large number of villages which were totally destroyed have been relocated to place not far away. The economy of the area is primarily farm based with very few industries [Jain, et.al; 1994].

Conclusion

Killari type Intracratonic earthquakes are either on a geological time scale or beyond recorded human history. By taking this fact into account the Govt. of Maharashtra has introduced environmental hazards and Disaster Management into general education to create long term and permanent awarness among its students. Earthquake observation on 29th September every year, is state organized event in Killari directed at making people to learn about earthquake and sustain the earthquake awarness. There is increasing trend towards RCC type house construction. Earthquake insurance is almost non-existent.

The Kobe earthquake 1995 was the most significant seismological event in Japan since the 1923, Great Kanto earthquake. The 1995 earthquake illustrated several structural short comings which Japan's Central Government and engineering community has quickly moved to address. To enhance overall construction quality in terms of construction, interim inspections are now required for all new buildings. All pre-1981 buildings in public use must have a seismic evaluation and retrofit if required. The Kobe earthquake 1995 illustrated the importance of hazard mitigation for complex urban environment depending upon a sophisticated array of transportation, communication and infrastructure system. It was also the first real test of Japan's post-1981 building code. The structure built to this newer code generally reformed well.

Earthquake recurrence has different meaning in different tectonic environment. While active regions such as plate boundries are prone to moderate, large and great earthquake, the plate interiors [intraplate] are associated with most slower deformation rate and therefore infrequent earthquake activity. In the absence of morphologic, tectonic and other features of past movement, evaluating the past earthquake poses a challenge. Nevertheless, the threat from Stable Continental Region [SCR] can't be underestimated, as they offer a false sense of security leading to casual altitude, when it comes to earthquake prepardness. The case of Killari's 1993 intracratonic earthquake in peninsular India is a good example of this situation.

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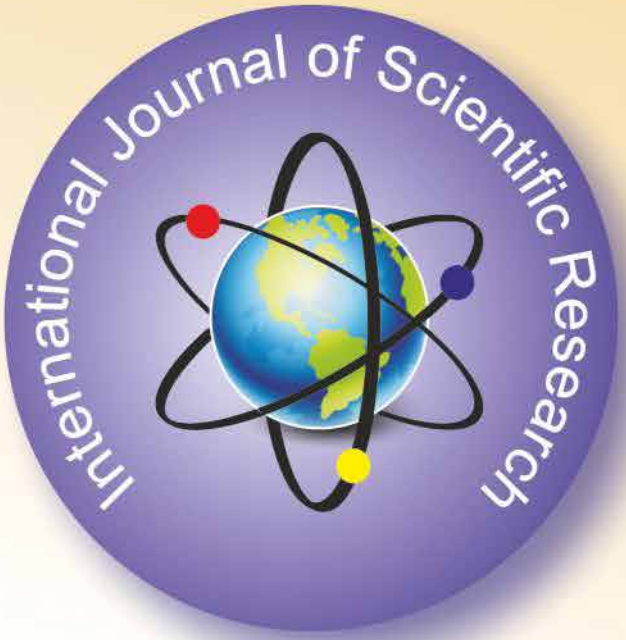

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