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Comparative Statistical Study on Delhi and Nepal's Geological and Seismographic Conditions

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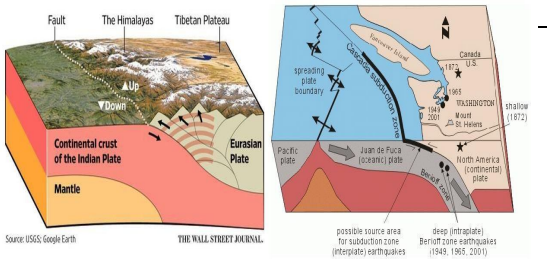
***Abstract:** An earthquake is movement of Earth's crust resulting from the release of built up potential energy between two stuck tectonic plates. This study is based on the seismological history of the regions and geological information which provides earthquake catalogues. Delhi being one of highly populated capital of India lying in Zone 4 in earthquake zoning pattern, having heavy and congested infrastructures. A series of destructive earthquakes struck in Nepal on April 25, 2015 and May 12, 2015, thousands of lives were losses and a massive loss happened in the earthquake. Infrastructure which is mainly responsible for earthquake disaster rather than earthquake itself, so demand of time is that they have to be modified accordingly. This study gives a review of earthquake statistics, efforts for earthquake mitigation, risk management in Nepal and Delhi.*
***Keywords:** Geology, Seismography, Statistics, Earthquake, Infrastructure.*

I. INTRODUCTION

Earthquake mainly occurs in India due to seduction of Indian plate under Eurasian plate. Earthquake can also occur due to construction of dams and Reservoir, excessive withdraw of underground water enhances vulnerability as underground water acts as absorber of seismic waves.



This Wall Street Journal image of the collision between the Indian Plate and the Eurasian Plate at Tibet shows the similarities the subduction zone has to the Cascadia subduction zone off Washington's coast.

II. LITERATURE REVIEW

A. Journal Natural Geosciences: (Springer,2008, page no=121 and Geosciences Journal, founded in 1997)

A massive underground Faultline that raptured in 2015, casing a killer earthquake in Nepal, is still under tremendous strain underneath Kathmandu. This meant another tremor could happen in or area have to more than 1 million people within year or decodes rather than centuries that typically elapse between quakes in 2015.

B. M7.8 – 36 km E of Khadi, Nepal". United States Geological Survey.25 November 2015. Retrieved 12 May 2015.

The April 25, 2015, M 7.8 Nepal earthquake occurred as the result of thrust faulting on or near the main thrust interface between the subducting India plate and the overriding Eurasia plate to the north.

C. Doctoral thesis, Experimental Study of Terrestrial Electron Anti-neutrinos Kalman, by Nikolai Tillich.

Doctoral thesis, Neutrino Geophysics and Observation of Geo-Neutrinos at Kalman, by Sanshiro Eno moto Ford University Website Neutrinos are also expected to provide fruitful information about Earth's energetics, because neutrino sources are also heat sources as well, and such radiogenic heats are believed to contribute a large part of Earth's heat generation, among other heat sources such as primordial energy of planetary accretion and latent heat of core solidification.

D. Johan Elliott of Oxford University. (Article of Nature Geoscience, Johan Elliott, Published on 11 January 2016)
Author said the rupture, shooting upward through the fault line from deep below, stopped abruptly 11 km Senath the Kathmandu, leaving on unbroken upper portion nearer the surface. As this part of the fault is nearer the surface, the future rupture of this upper portion has the potential for a much greater impact on Kathmandu if it were to break in one go in a similar-sized event that of April 2015.

E. Dr. CP Rajendra: (The Hindu newspaper,29 march 2010 his article is published)
Earth Sciences says that a major earthquake is due in central Himalayas as no big trembler has shaken the region for the lost several years. If such an earthquake takes place then it has the potential to flatten Delhi.

F. Charles Lyell in his "Principles of Geology" was perhaps the first to appreciate the scientific value of landscape changes, created by earthquakes. A classical case, among others, to which he made reference, was the 1819 Ran of Kachchh earthquake that produced dramatic land level changes.

G. "Nepal Says Earthquake Rebuilding Cost to Exceed $10 Billion". 28 April 2015. Retrieved 22 May 2017 – via www.bloomberg.com. The cost to rebuild Nepal after its most devastating earthquake in eight decades will exceed $10 billion.

H. Three dimensional periodic foundations for base seismic isolation by Y Yan, Z Cheng, F Men, Y L Mol, Y Tang and Z Shi. Published 3 June 2015 • © 2015 IOP Publishing Ltd, Smart Materials and Structures, Volume 24, Number 7. e years.
Based on the concept of photonic crystals, periodic foundations made of periodic materials are investigated in this paper. The periodic foundations can provide low frequency band gaps, which cover the main frequency ranges of seismic waves. Therefore, the periodic foundations are able to protect the upper structures during earthquake events. In this paper, the basic theory of three-dimensional periodic foundations is studied and the finite element method was used to conduct the sensitivity study. A simplified three-dimensional periodic foundation with a superstructure was tested in the field and the feasibility of three-dimensional periodic foundations was proved

III. EFFECTS OF EARTHQUAKE

3.1 One particular feature that can change the balance of forces in Earth's crust is ice, in the form of glaciers. The ice sheets that cover much of area around earth's plate plus maintains at all latitudes. The weight of ice depresses the crust on which it sits. As ice melts, the crust below no longer has anything sitting on top of it, and so can rebound fairly rapidly (by geological standards) Area of rebounding crust could change the stress acting on earthquake facts and volcanoes in crust.

Fig (2) Image showing destruction by earthquake

IV. STEP BY GOVERNMENT

National Earthquake Risk Mitigation Project (NERMP): Understanding the importance of the management of such hazardous situations caused by Earthquakes, the Govt. of India has taken a national initiation for launching project of National Earthquake Risk Management Project (NERMP). The proposed project aims at strengthening the structural and non-structural earthquake mitigation efforts and reducing the vulnerability is the high-risk districts prone to earthquake. But the fact is in India steps are taken when earthquake or any disaster has happened already. It is also a rough that only 20% of buildings in cities like Delhi follow National Building Code(NBC).
Earthquake resistant buildings are based on following techniques:

Base Isolation Method: - In this case the building would be separated them the surface by using cylinder, bell bearings or springs. Use of vibration dampers: - In this case carbon fibers or viscous of the building to absorbs the seismic waves. In relief operations technical UAVs (Unmanned Aerial Vehicle) or drones as well as snaking Robot can be used. Smoking Robots identify people trapped inside the building. The infrastructure should be properly developed devoid of then the relief operations cannot reach in time. If communication network fails HAM ratio or satellite phones can be used. People should be aware of seismic norms properly.

V. SEISMIC METAMATERIALS

A. Someday in the future, when an earthquake hits a major city, we may be able to redirect the acoustic waves of the earthquake to a place where they won't cause so much damage. At least, that's the idea proposed by scientists at the Aix-Marseille University and French National Center for Scientific Research (CNRS). The scientists teamed up with French company Minard to conduct a large-scale experiment that uses metamaterial technology to deflect acoustic waves like those generated in an earthquake. So far, the results have been promising.

B. When an earthquake hits an area, it sends shockwaves up to the surface of the Earth from underground. When these waves reach the surface, much of the energy shifts into waves that move along the surface of the Earth. It's these surface waves that usually cause the most damage to human-made structures and pose the greatest threat to life; this is why scientists want to see if they can possibly block or shift the waves so that they cause less harm.

C. Following the advent of electromagnetic metamaterials at the turn of the century, researchers working in other areas of wave physics have translated concepts of electromagnetic metamaterials to acoustics, electrodynamics, as well as to heat, mass and light diffusion processes. In electrodynamics, seismic metamaterials have emerged in the last decade for soft soils structured at the meter scale, and have been tested thanks to full-scale experiments on holey soils five years ago. Born in the soil, seismic metamaterials grow simultaneously on the field of tuned-resonators buried in the soil, around building's foundations or near the soil-structure's interface, and on the field of above-surface resonators. In this perspective article, we quickly recall some research advances made in all these types of seismic metamaterials and we further dress an inventory of which material parameters can be achieved and which cannot, notably from the effective medium theory perspective. We finally envision perspectives on future developments of large scale auxetic metamaterials for building's foundations, forests of trees for seismic protection and metamaterial-like transformed urbanism at the city scale.

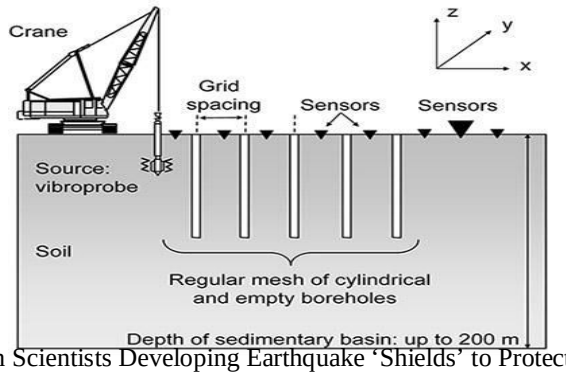


Fig. (3) French Scientists Developing Earthquake 'Shields' to Protect Cities from Quakes.

A. Geoneutrino

"Geoneutrinos" are electron antineutrinos produced by beta-decays of the nuclei in the decay chains of 238U and 232Th. Amland is the first detector to conduct an investigation on geoneutrinos.

1) *Geophysics:* The Earth can be split into 5 basic regions according to the seismic data: core, mantle, oceanic crust, continental crust, and sediment. All these regions are solid except for the outer core. Even though the mantle is solid, it convicts. The mantle convection is responsible for the terrestrial phenomena such as plate tectonics and earthquakes. The oceanic crust is renewed at mid-ocean ridges and recycled back into the mantle at subduction zones. So, the typical oceanic crust (~80 million years old) is much younger than the continental crust (~2 billion years old).

2) *Flow Measurement from the Earth***:** The Earth's conductive heat flow has been evaluated to be 44.2TW, or 31TW (with an assumption of lower hydrothermal heat flow near mid-ocean ridges). These evaluations use borehole temperature gradient and conductivity measurements. These borehole measurements are concentrated in the US, Europe, and Japan. The deepest borehole is ~12km, 1/500 of the Earth's radius.

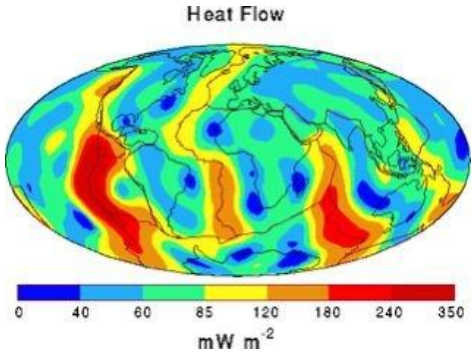


Fig. (4) Image showing Heat Flow Measurement from the Earth.

3) *Radiogenic Heat in the Earth:* The radioactive isotopes inside the Earth generate heat. In particular, decays of the daughter nuclei in the decay chains of ^{238}U and ^{232}Th, and ^{40}K generate most of the radiogenic heat produced. According to the estimated concentrations of these isotopes described below, the radiogenic heat production rates are 8.0, 8.3, and 3TW for ^{238}U series, ^{232}Th series, and ^{40}K decays, respectively. The sum of the estimated radiogenic heat production rate, ~19TW is only about the half of the total heat flow measured using the borehole measurements. According to some of the mantle convection models, these two numbers, 44TW (or 31TW) for the total heat dissipation rate from the Earth, and 19TW for radiogenic heat production rate should be similar.

As these radioactive isotope's beta-decay, they produce antineutrinos. So, measuring these antineutrinos may serve as a crosscheck of the radiogenic heat production-rate

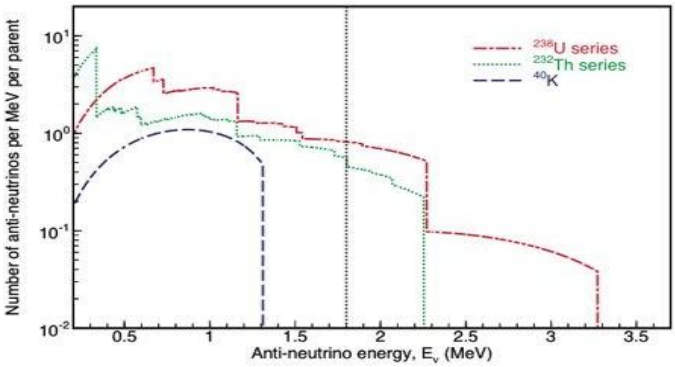


Fig (5) Graph showing Radiogenic Heat in the Earth.

VI. CONCLUSION

Earthquake don't kill people, building do whoever said these words rightly defended a natural course of action. Nepal Earthquake of magnitude 7.8 has left many dead and injured. One shake and buildings collapsed like a rock of cards.

Also India had few earthquakes in the past which saw our cities face significant loss of lives and livelihoods. The Bhuj earthquake in 2001 is one such example where the city of Ahmedabad witnessed massive damage in spite of the fact that the earthquake epicentre was properly worth 35 thousand crore got destroyed.

Our wilful amnesia prevents us turn taking adequate precautions while building our cities. One of the cities is our capital city which is still in its evolving phase.

Delhi and NCR, the emerging urban city is a perfect example of thoughtless mushrooming of concrete structures.

We have also seen the buildings constructed in N.C.R. could not stand rain of one hour. A single Bhuj and Nepal like tremor can turn this urban aspiration into a supermarket of ditch and destruction.

"Earthquake Management in India is itself an Earthquake"

"Therefore, a country like India which is second most populous country of the world and whose more than 50% of landmass is under threat of severe earthquake should explore future materials such as metamaterials, geoneutrinos etc. which could be gamechanger in fighting earthquake."

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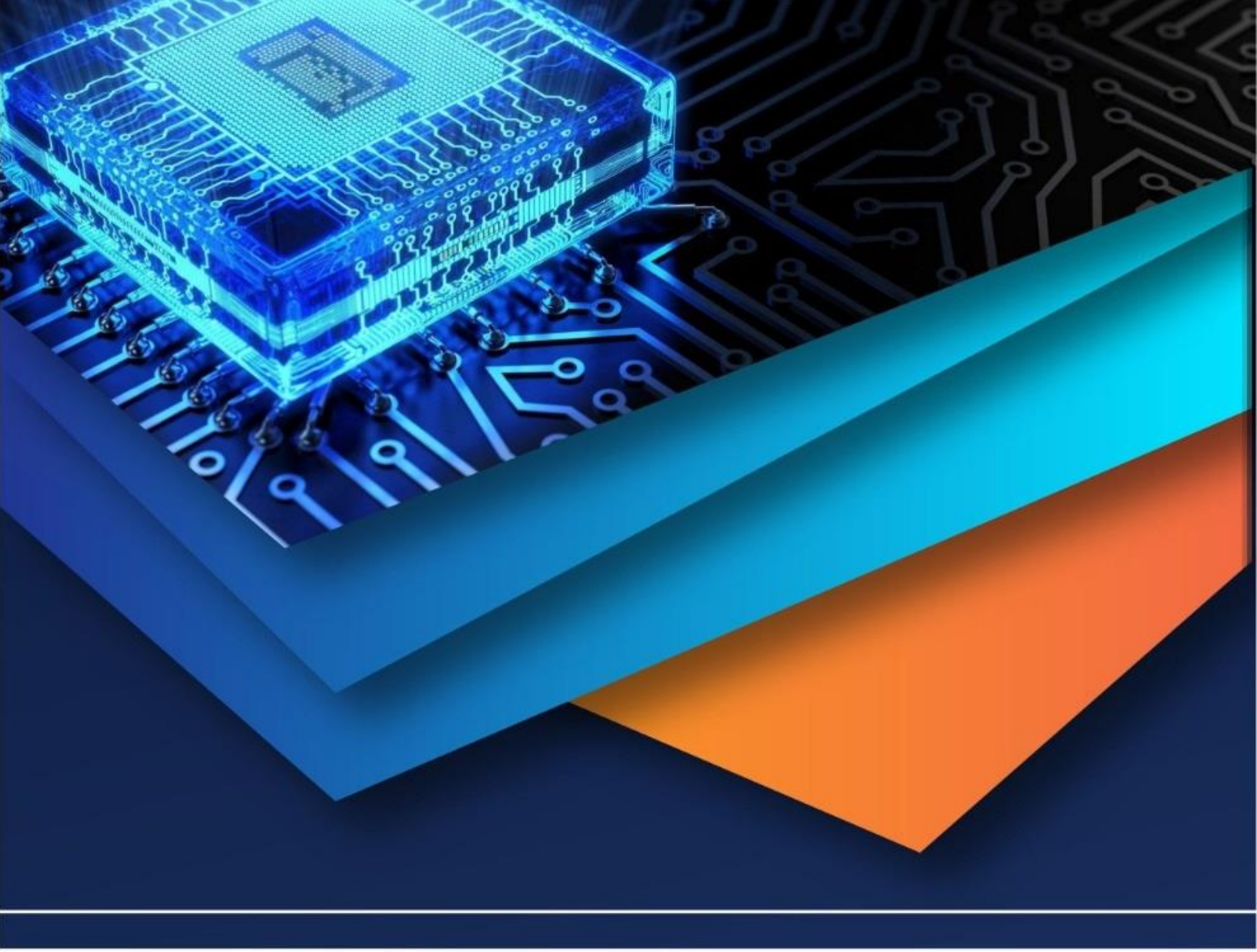
[5] Restudies Massive Floating Ark Battles Rising Tides.
[6] American Physical Society and Engaged.
[7] French National Center for Scientific Research (CNRS)
[8] Stanford University



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