Advancement in Construction Techniques of Earthquake Resistant Buildings

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Abstract

In the modern age of civilization when population of developing country like India is growing rapidly, the problem to accommodate the people of the country in a planned way is really crucial due to restriction in land, hence now the developers are bound to adopt high rise building construction instead of low rise. As we increase the height of a building by constructing floor over the floor, the dead load of the building increases itself due to more construction material weight and density and hence, the chance of failure of structure also increases during arrival of any intense load state like earthquake or any further parallel disaster which can yield any kind of influence or inadequate settlement in the building. Generally, skyscrapers need more attention in earthquake resistant design and materials. Thus, the techniques of constructing the Highrise structures are growing rapidly. Indian seismic codes illustrate not only various modern techniques but also old traditional techniques for earthquake resistant construction of buildings. On observing these codes, some techniques are witnessed to be not only cost effective but also provides easy approach in construction of the buildings itself. In a nut shell, this research paper is an outcome of best earthquake resistance technique adopting in developing country like India.

Introduction

Since the existence of the human on earth disasters are the unpredictable incidents that are affecting the human lives unsympathetically. In regards to this instance, attempts have been made consistently to alleviate overwhelming results of these disaster. It is a matter of fact that courageous results of such attempts are appearing in the developed countries but unluckily and sadly imperfect for the developing countries like India. Since ancient time, the biggest natural disaster for human lives and prosperity is earthquake on the earth. Such sudden terrible events of earth shake produce devasting effects on economic and social lives of the people. It is really a matter of great shock and disturbance for man who looks upon the earth as a mother where he supposes safe life reacted with a trembling, is really frighten. Alleviation of the catastrophic destruction produced by earthquakes is of major demand in most of the country in the world. To overcome with this enforceable and inescapable situation the only way is to make our buildings earthquake prone by considering all earthquake resistant parameters of design and materials. Similar attempts have been made to resolve this problem all over the world. As an outcome of the studies made by different researchers in this regard is that developing countries are more susceptible to damage rather than developed countries by occurrence of such disaster. Earthquake has not been responsible for such kind of destruction but the elementary reason of damage is the insecure designed and poorly

constructed structure. Controlling the mortality rate and damage in economy in such disasters, now has become the large issue for the worldwide. Various researches are going on to rectify the cause of failure in such devasting situations. Now it is the need of the people to live in a properly earthquake resistant buildings with a happy and prospers lives. In a nut shell, the only person which can provide the peaceful lives against such disasters are the structural / civil engineers who designs and construct our houses earthquake resistant with latest techniques as in developed countries like Japan and USA.

Now in all developed countries adopting the standards governed by various codes of practices for earthquake resistance design of the structures. The standards specified in the code of practices consists all parameters of analysis, design and construction of structures. The wide range of these standards are based on the knowledge of parameter accounting in earthquake related to seismic regions and earthquake also that is able to integrate advanced concepts and development of their fields. This is also a matter of surprise that the basic codes and standards in both developing and developed countries are same in their specifications because the concept of earthquake resistant design is also same in worldwide but still the collapse of a structure in developing country becoming more prominent. This indicates either the implementation and compliance of the technique of earthquake resistance in the developing countries are not suitable to follow and implement such standards in the buildings during their construction.

The outcome of the various researchers about the local techniques of earthquake resistance construction in many countries are extremely variable in their choice of construction techniques and materials. They can be grouped together based upon their analytical elements furnishing resistance against earthquakes. The earliest earthquake-resistant construction techniques may utilize more than one of these elements. The complete comprehensive conversation is listed below,

Knowledge about Ancient Earthquake Techniques: -

The focus for the traditional methods of earthquake resistance building so far is only anxiety to resist the massive forces. These traditional techniques of earthquake resistant structure can be separated after contemplation of their structural conduct as illustrate in the following points,

- Earthquake resistance building techniques using robust architectural forms – in particular structures with balanced plan and elevation.
- Earthquake resistance building techniques using resilient structural shape – for instance structures with bands and braces.

Ductile Materials for Construction:

Traditionally ductile materials particularly timber and bamboo were in used for earthquake prone construction in various region of world. It has been found that traditional timber construction technique was universal from equatorial to temperate regions while bamboo construction practice was more prevalent in equatorial and tropical regions. These highly ductile materials have the capability to undergo large deformations without failure. The ductile property of these materials is ideal for construction of earthquake resistant houses that need to resist intense ground motions. The ability of the

connections particularly to resist the demands needed for the earthquake resistance connections imposed due to large deformations of the structural elements. The ductile materials were the connection systems for traditional constructions therefore they play a indispensable role in deciding the earthquake resistance of these constructions. For instance, China has developed very specific connection system for timber constructions that allow them to construct large earthquake-resistant structures for the lives of more hundreds of years. The highly earthquake resistant techniques of low-cost building like all other construction practices using bamboo or a combination of bamboo and timber and also meet the other functional conditions. Various countries in different part of the world are normally using these technologies for earthquake resistant construction. The tremendous achievements were shown by the constructed houses and buildings using these techniques during earlier earthquake. As we know that both timber and bamboo are suspectable to decay hence proper maintenance is prime requirement of the buildings made from these materials time to time in different weather conditions. Therefore, these materials of earthquake resistant buildings are normally used for construction of those buildings for which durability is not the prime requirement or are used in construction of temporary structures. For major permanent and long-lasting structures of earthquake-resistant constructions the treated timber have been developed to satisfy this requirement. The frame systems or walls not only resists the earthquake forces but also provides lateral stiffness to the buildings. In providing better strength to these frame system of earthquake resistance structure the use of local materials is prohibited during construction. Nevertheless, the walls are joined together using bands at different levels so that they behave like an whole unit. The distribution of inertia forces in the course of the earthquake provides high seismic resistance to all walls of the buildings. Another material like tiny dressed stone masonry pieces interlocked together without mortar to construct the wall and were used in Kashmir, India for constructing earthquake prone buildings. The forces of earthquake among these tiny stone pieces of wall provides the ability to vibrate rubbing against each other so that they can dematerialize the earthquake energy and enhance the earthquake resistance. There are numerous frame structure are reported in literature that provides high seismic resistance. Various countries in the world are using timber or bamboo constructions with diagonal braces. For protecting these structures from earthquake forces in their seismic region the special connection details are used in these constructions to connect the braces to the frame to ensure integral action during earthquake loading. In Turkey, the traditional construction technique consists simplest bracing systems that use diagonal timber brace with timber frame. In India, the Assam is also using the diagonal braces system in constructing their houses. In, central America, Bahareque is constructing their buildings more complex using a combination of timber frame with bamboo ties that reduces the impact of seismic forces. The forces generated during an earthquake are the inertia forces and are directly proportional to the mass of the building. In Japan, they are using traditional construction practice like partition walls of very low weight to reduce the seismic forces. As per the functional demand of the building, they are constructing earthquake-resistant buildings with such material that provides heavy exterior walls and roofs but low weight internal walls. Japan is using these unique technique of internal walls results in reduced privacy but that is culturally acceptable in that country.

Reduction of Seismic Forces

Very rare constructions method in some small countries as a example of indigenous earthquake-resistant structure that decrease the seismic forces through similar drop in mass are reported. Eventually, in simple architectural formation of these indigenous constructions, the majority is using various structural methods for improving the lateral resistance of the buildings. Timer and bamboo are the main advantageous material in several earthquake-resistant construction techniques. Considering the weather safety factor of building, stone and brick masonry constructions are also popular in different parts of the world. Stone and brick masonry constructions techniques have been used for earthquake-resistant buildings by various architectural forms and structural configurations.

Research, development and implementation of ancient technologies

The most current significant interest in research and development linked to ancient earthquake resistant skills that is popular in several countries of the world. Lot of the research activities are, however, limited to documentation of the earthquake-resistant features. Inconsiderable researchers are focusing on quantitative development of these indigenous techniques and also understanding the behavior of these constructed structures so that these technologies can be further improved and analytical methods for their use can be developed. Generally, these ancient technologies are using the local materials whose properties are highly variable, hence quantification of their engineering character t is considerable difficult. It is also difficult to develop the analysis and design for research these structure in the absence of well-defined material properties. Hence the researchers basically focused on development of prescriptive design and construction guidelines for such construction. In absence of well-developed analytical design tools, these technologies appear to be less “modern” and more prone to unsatisfactory performance due to uncertainty in the material properties. However, the cost of construction is found to be very low in using of traditional local materials. If the ancient technologies be used in the costly developed areas in place of RCC or steel structures for construction which are mainly used in construction in areas with high-cost sensitivity, these constructions can be used to provide a “minimum” level of seismic safety at significantly lower cost compared to those of RCC or steel. For enhancement the performance of these modern construction techniques in the developing countries where the report is poor in terms of safety of the buildings due to earthquake, so it is very much required for the increase in overall level of earthquake resistance of the building stock retraining of the entire construction industry: the architect, the engineers, the contractors, the skilled workers, the semi-skilled workers and the unskilled workers. All these responsible persons for critical decision require to enhance their skill of making decision of construction projects by these techniques. The retraining, if and whenever implemented, provides massive benefit to the economically prosperous people of the society. However, the people of economically weaker sections of the society can’t afford such skilled architect and construction engineers to construct their homes. Under these circumstances, the ancient earthquake resistance technologies can be proposed for the use of economically weaker sections because the cost of construction in these technologies is significantly low in comparison to those using modern construction

materials. The use of these technologies generally involves only the skilled, the semi-skilled and the unskilled workers and these workers are require to be suitably trained to ensure that the buildings provide the minimum level of seismic safety. A lot of countries of the world are using the strategy following devastating earthquakes. India particularly in the Kutch region and Turkey are using these indigenous technologies in some areas for earthquake-resistant buildings that already existed but were not used due to widespread induction of modern construction techniques have been reinvigorate. In Iran and particularly Killari in India, earthquake-resistant construction technologies based on locally available materials were inducted from other earthquake-prone regions. In connection with all such situations, the use of local materials and ancient earthquake-resistant technologies have been found to provide a economic means for sustainable construction of numerous buildings.

Conclusions and Discussions

The outcome of this research paper is to provide a brief description of the development of ancient earthquake-resistant technologies in various countries to the different parts of the world. The circumstances leading to their development and highlights the ability of ancient cultures and civilizations to collect and process scientific knowledge spanning several generations are reported in this paper. This paper is a vast explanation in regards to the key features of all earthquake-resistant indigenous construction technologies. The essential elements of all the technologies can be categorized into four classes:

(1) Resilient structural configurations,

(2) Reduction of seismic forces,

(3) Ductile construction materials and

(4) Robust architectural forms

Multiple elements are required for resistance towards earthquake in most of the earthquake-resistant construction technologies. It is also been observed that modern analytical design procedures in no way be stretched to the usage of indigenous construction skills due to unpredictability in material properties. However, there is a vast need of to develop authoritarian design and construction procedures based on current knowledge at the minimum level of safety to these constructions. It is also seen that the use of indigenous earthquake- resistant construction technologies provide an excellent opportunity for economic large-scale construction of earthquake-resistant housing in developing countries. However, the great attention is requiring to expand the research and development activities in this field for further improvement in these technologies and also make them sustainably suitable as modern construction techniques.

BIBLIOGRAPHY

1. Erdik, M. “Report on the Turkish earthquake of October 30, 1983.” Earthquake Spectra 1984; 1:151- 172.
2. Earthquake Engineering Research Institute (EERI). World Housing Encyclopedia (www.worldhousing.net).
3. Langenbach, R. “Intuitions from the past: What we can learn from traditional

construction in seismic areas." International Conference: Earthquake Safe: Lessons to be Learnt from Traditional Constructions, Istanbul, Turkey 2000

4. Homan, J, and Eastwood, WJ. "The 17 August 1999 Kocaeli (Izmit) earthquakes: Historical records and seismic culture." Earthquake Spectra 2001; 17: 617-634.
5. Mendes-Victor, L, Ferrigni, F, Mauro, A, Pierotti, P, Helly, B, Rideaud A. Ancient Buildings and Earthquakes, European University Center and Council of Europe 1997.
6. Shiping, H. "The earthquake-resistant properties of Chinese traditional architecture." Earthquake Spectra 1991; 3: 355-
7. 389Ofori, G. "Construction industry development for disaster prevention and response." Improving PostDisaster Reconstruction in Developing Countries, Montreal, Canada 2002.
8. Sinha, R, Shaw, R, Goyal, A, Choudhary, MD, Jaiswal, K, Saita, J, Arai, H, Pribadi, K, and Arya, AS. The Bhuj Earthquake of January 26, 2001, Indian Institute of Technology Bombay and Earthquake Disaster Mitigation Research Centre, Miki, Japan (Joint Publication) 2001.
9. United Nations Center for Human Settlements (Habitat). Earth Construction Technology, Habitat 1992.
10. Dr. Mohan M. Murudi, Mr. Sharadchandra M. Mane (2004) "Seismic Effectiveness Of Tuned Mass Damper (Tmd) For Different Ground Motion Parameters" 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 2325.
11. Fahim Sadek, Bijan Mohraz, Andrew W. Taylor and Riley M. Chang 1997)," A Method of Estimating the Parameters of Tuned Mass Dampers for Seismic Applications", Journal of Earthquake Engineering and Structural Dynamics, Vol.26, pp 617- 635.