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Disaster Management- Construction and Designing of Earthquake Resistant Buildings in Aligarh City (A Case Study)

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Abstract Earthquake is considered as major natural disasters which affect most of the parts of India. Earthquakes caused huge damage to life and property national level as well as global. India poses a significant threat earthquake vulnerable zone of falling by almost 59% of the geographical area. Severe damage and poor performance of buildings in all over the India during an earthquake are a matter of serious concern in which Aligarh is of one of the city in India.[1] Disaster management is an approach which minimizes the impacts of earthquakes on life and property. First of all broad outline information about a particular area (study area) has been collected which includes topography, demography, seismic category by field monitoring. A field survey was conducted to assess the expected seismic performance of multi-stores, buildings (engineered buildings) as it checks the efficiency of new construction and designing of buildings and the code of earthquake resistant construction of buildings (including the materials used in the construction). This survey carried by the data collected from the persons living in different area about the little bit knowledge related to the earthquake. In this respect disaster management deals the construction of safe and secure buildings in that particular area, along with local awareness about the causes, effect and mitigation measures of earthquake. Evaluation of new construction techniques, along with increased understanding of seismic forces and building response certainly contributed positively to reduce the seismic vulnerability and prevent loss of lives, property and environmental degradation.
Keyword *Disaster; Earthquake; Resistant; Topography; Mitigation; Seismic Forces*

1. Introduction

India's A disaster can be extensive defined as any tragic event with great loss stemming from events such as earthquakes, floods, catastrophic accidents, fires, or explosions. An Earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rocks beneath the earth's surface. Over time, stresses build beneath the Earth's surface. Occasionally, stress is released, resulting in the sudden, and sometimes disastrous shaking we call an earthquake [4, 5]. Earthquakes are among the most deadly natural hazards. They strike without warning and many of the Earth's earthquake zones coincide with areas of high population density. It badly damages the lives, economy and buildings so disaster management in this respect means to minimize its loss by the construction of earthquake resistant buildings which tolerate the high magnitude of the earthquake [14]. The earthquake on the Richter scale does not mean that there will be more destruction and damage. What is more important is how well educated persons are responding to earthquakes and how much money can be spent on making buildings, bridges, pipes etc. Able to respond to actions of the earth. The earthquake caused by the rupture of rock zones called as faults. A fault is a thin zone of crushed rock between two blocks of rock, and can be any length, from centimeters to thousands of kilometers. When an earthquake occurs on one of these faults, the rock on one side of the fault slips with respect to the other. The fault surface can be vertical, horizontal, or at some angle to the surface of the earth. This movement transmitted the seismic waves from the bed rocks which cause rupture and movement of tectonic plates [3, 11].

The main focus of disaster management for the earthquake are- Check the causes and impact of natural disaster- earthquake on life, property and Environment. To check the awareness among the people regarding the harmful impacts of Earthquake and its remedial measures, encourage the local person to construct Earthquake resistant buildings, Insure Proper Implementation of Building Bye-laws and Safe Construction Practices. Develop City Disaster Management Plan, Training and Qualification of the Community on Urban Risk Reduction and ultimately develop emergency support functions [7, 8].

Earthquake-resistant design (EQRD) of structures has grown into a true multi-disciplinary field of engineering. Several parameters that determine the demand and capacity and how design codes tries to define them and specify a standard for the design of a performance structure shown in Figure 1 process. Several strategies to provide adequate capacity to mitigate the seismic response of a structure were also listed. Likewise, the demand side, several factors that characterize the motion of the soil which determines the severity of the demand are listed [10].

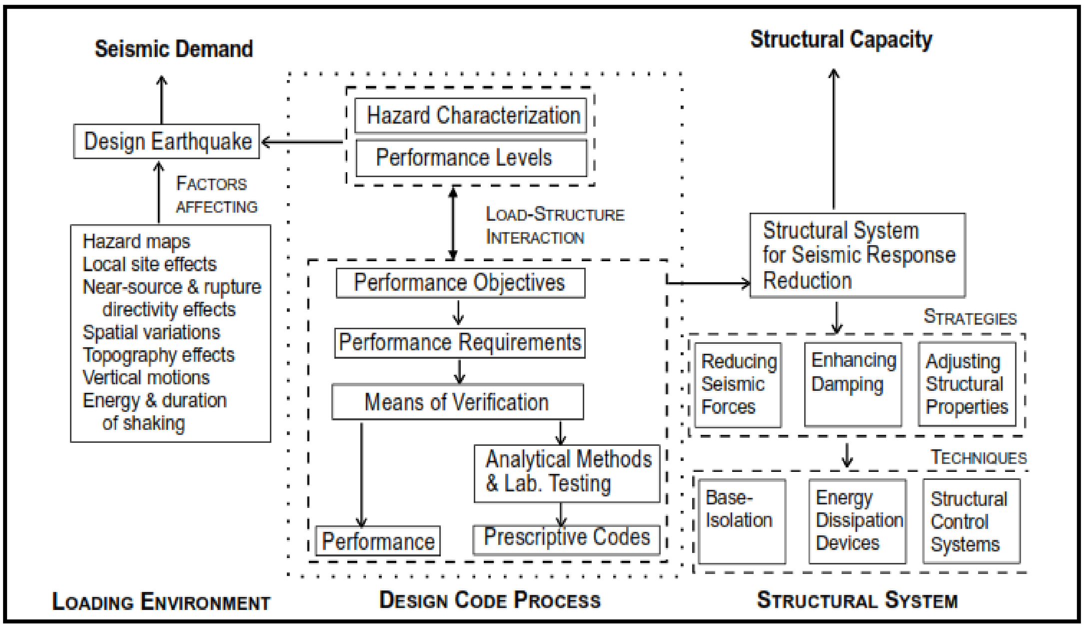


Figure 1: *The Inter-Relationship between Seismic Demand and Structural Capacity as Applied to EQRD*
(Source: Rai, 2000)

2. Construction and Designing of Earthquake Resistant Buildings

Structures in seismic regions shall be designed and constructed in such a way that the following, more specific requirements are met, each with an adequate degree of reliability. The most direct approach will be to compare the safety provisions specified in the building code IS: 4326-1993, “Earthquake Resistant Design and Construction of Buildings – Code of Practice (Second Revision), Bureau of Indian Standards” for such buildings with the condition actually present in an existing building. When the existing state is found to comply with the code, it will be considered safe and acceptable. But where any existing condition is poor, therefore, do not comply; he will be regarded as weak and damageable. Such a deficiency will require grading or building or modernization [6].

2.1. Type of Building Construction

The following building types can be assessed by the simple procedure covered here:

a) Brick wall buildings with any mortar and roof type.
b) Concrete block wall buildings with any mortar and roof type.
c) Fully dressed stone (Ashler masonry) wall buildings with any mortar and roof type.

The building can be entirely residential or mixed use. Only those aspects of earthquake safety should be assessed. It is assumed that the building is another safe way to carry the vertical weight of the roof and floor as well as the loads imposed relating to the use of furniture, partitions, people and content as merchandise, office equipment, etc.

The factors considered most important in the Code to assure the seismic safety of buildings of various categories are as follows: [10]

I) For the Safety of Walls

- The mortar used in foundations and walls
- Size and placement of door, window openings in walls
- Length of the wall between the transverse walls
- Height of wall above the floor to ceiling
- Walls perpendicular disconnected.
- Provision of horizontal seismic bands

a. Plinth level
b. Door and window lintel level
c. Ceiling apartment floor / ceiling, or the level of the eaves of sloping roofs
a. Top of the ridge and gable wall
b. Level window sill

- Provision of vertical steel bars

a. In every corner / junction of walls
b. The door and window jambs

II) For the safety of roofs or floors

- (I) Rooftops / storey precast or precast
- Balconies (II) cantilever
- (III) Roofs / floors and wooden beams with various elements of cover

- (Iv) Jack arches ceiling or floor
- (V) Pitched roofs with sheets or tile roofs
- (VI) Sloping roofs raftered

Seismic Safety of Buildings (General guidance for masonry) [12]

- A single storey building using a brick thick wall will be relatively safer than a three-story. The fourth floor was added; it will be unsafe and will cause lower floors more vulnerable.

- Use of a half - wall thickness (10-11.5 cm or 4-4 ½ " thickness) of load bearing walls will cause very unsafe conditions during seismic intensity VIII in MSK intensity scale and, if used on the 3rd and 4th floor, it can have a catastrophic failure.

- Too window openings make a weaker wall pillars and use of smaller size less than 18 inches (45 cm) width between the two further increases damageability.

- Richer mortar of cement and sand of 1:4 (cement 1 part with 4 parts of sand) causes the strongest earthquake shaking masonry against compared with 1:06 mortar by a factor of 2.5 to 3.0. Also 1:06 mortar is stronger than lime cinder or lime mortar - surkhi.

- Use of clay mud mortar produces the weaker masonry. His strength in dry condition reduces to less than 50 percent when the walls get wet during rains. Therefore, the use of a good plastering is essential to protect such masonry during the rainy months.

- Hiking longer between consecutive cross walls are found weaker than shorter walls. The length is controlled for safety by limiting the length and thickness.

- Higher walls between any two floors are found to be weaker than shorter walls. The height of the floor is controlled by limiting its height in relation to thickness.

- All four walls enclosing a room should be properly connected at individually corner. Walls not so coupled will easily separate at corners and drop under earthquake motion.

- The most important requirement of seismic safety is the provision of seismic bands on all floors in all external and inner walls. These bands sustain the integrity of the entire building as a unit under earthquake shaking. In addition to the safety event, this also increases the stability of walls according to vertical loads.

- The roof structure of sloping roofs needs their integrity through bracing and proper connectivity with the walls. This integrity is automatically provided by reinforced concrete slabs were used for floors and roof.

Figure 2 and Figure 3 Model engineering building under The Indian Standard Code of Practice IS: 4326–1993 covers all these aspects in detail and gives specific guidance as to how to incorporate them in the earthquake safe construction of all types of new masonry buildings [9].

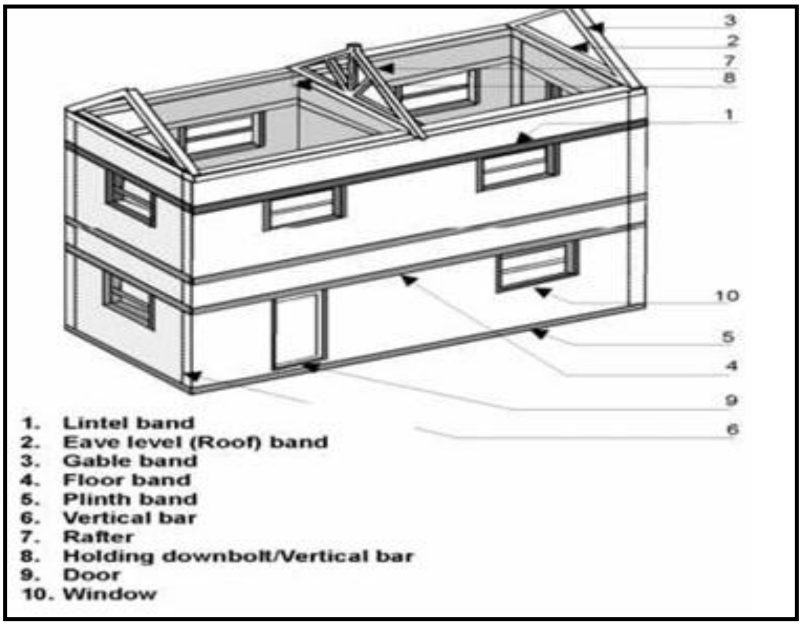


Figure 2: *Model Engineering Building under the Indian Standard Code of Practice for Earthquake Resistant*

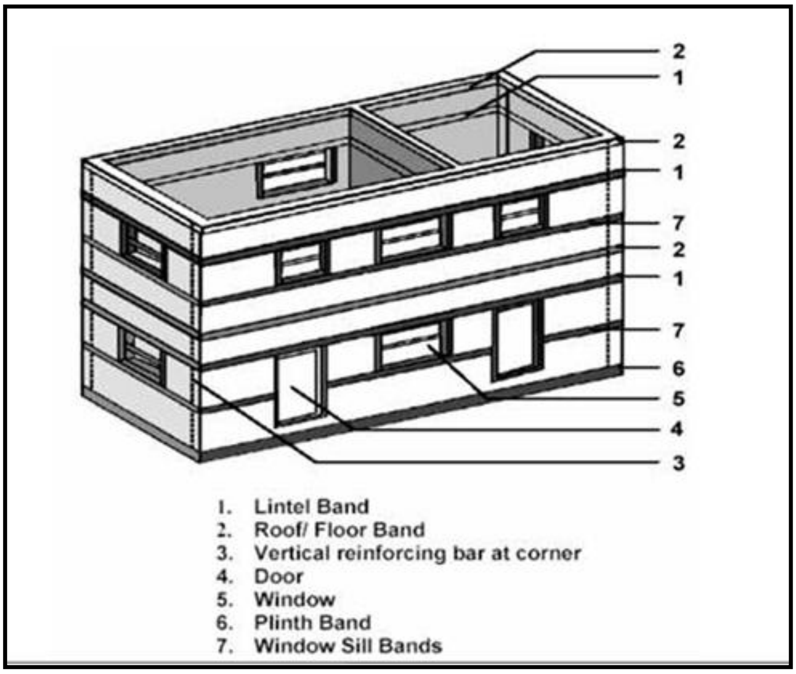


Figure 3: *Model Engineering Building under the Indian Standard Code of Practice for Earthquake Resist*

3. Study Area

Aligarh is a prominent industrial town in the state of UP. Aligarh is located at 27°53'N 78°35'E. It has an average elevation of 178 meters (587 feet). The city is spread over an area of 38.29 km². The Bureau of Indian Standards is the official organ for publication of maps of seismic hazards and codes. He brought out versions of seismic zoning map: a map of the area six in 1962, seven areas a map in 1966, and a map zone five 1970/1984. About 56.3% of Aligarh city comes under seismic zone-IV and remaining area, come under seismic zone–III. Aligarh, with the passage of time had grown into 4 parts. (Figure 4) UPPER KOT AREA, ACHAL TAL AREAS, CIVIL LINES AREA, PERIPHERAL RING AREA. Further, these 4 parts were divided into 15 localities (Table 1).

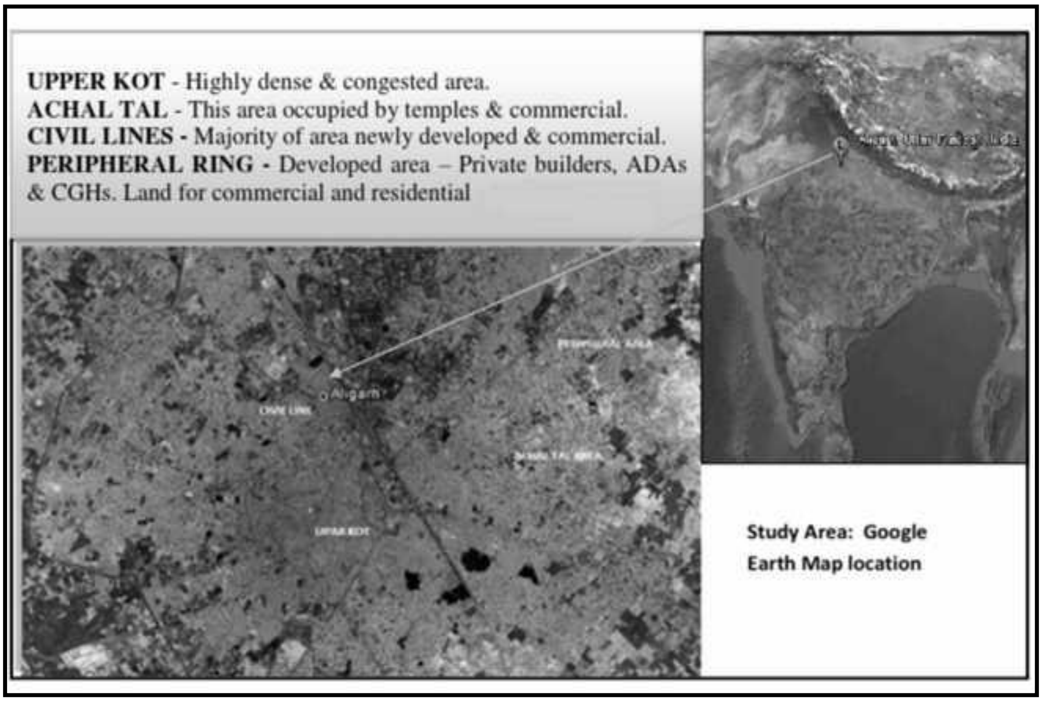


Figure 4: *Satellite Image Showing Study*

Table 1: *Name of Localities*

S. No.	Localities Code	Localities Name	S. No.	Localities Code	Localities Name
1.	Locality 1	Mansarovar Colony	**9.**	Locality 9	Rambagh Colony Gali No.2
2.	Locality 2	Gyansarovar Colony	**10.**	Locality 10	Rambagh Colony Gali No.3
3.	Locality 3	Ramesh Vihar Colony	**11.**	Locality 11	Rambagh Colony Gali No.4
4.	Locality 4	Niranjanpuri Colony	**12.**	Locality 12	Rambagh Colony Gali No.5
5.	Locality 5	Jankpuri Colony	**13.**	Locality 13	Rambagh Colony Gali No.6
6.	Locality 6	Avantika Colony	**14.**	Locality 14	Vikram Nagar Colony
7.	Locality 7	ADA Colony	**15.**	Locality 15	Baigpur Colony
8.	Locality 8	Rambagh Colony Gali No.1			

ADA Colony Apartments situated in a Dense Population Area

OZONE City Situated in the low Dense Population Area

SANGWAN City Situated Newly Area (Extension of City)

Figure 5: *Satellite Image Engineered Construct Resistant Buildings in Aligarh*

The city had poor infrastructure, both in terms of quality and quantity so there is more need of resistant constructions. And data vary in different localities on the basis of criteria-Living standards, Economic conditions, Literacy of person, Locality condition, Crowd of locality and Population in the locality. The main study site is peripheral area which is a newly developed area and having engineered construct resistant buildings. Some examples in (Figure 5) of such constructions are-SANGWAN CITY, OZONE CITY, ADA Houses and SANKALP ENCLAVE etc.

4. Methodology

The survey has been done since the month of March to May 2011. Data have been collected from 20*15 houses of each locality for the satisfactory result. During this survey few question has been asked of the persons related to the disaster (Earthquake) and checks whether they are aware or not. This survey contains some questionnaires. In a second step valuable information has been collected from site engineers' like-What is earthquake resistant construction? How can be constructing these types of houses? What are the materials required in safe construction? What are the standards of safe houses in this zone? What will be the total expenditure of resistant construction?-

After the survey and collection of information from the local person a rough report has been prepared. There after factual information and study literature related to the causes, effect and remedial measures of Earthquake have been collected from different Books, Text Journals (International and National), Internet and Official websites.

5. Results and Discussions

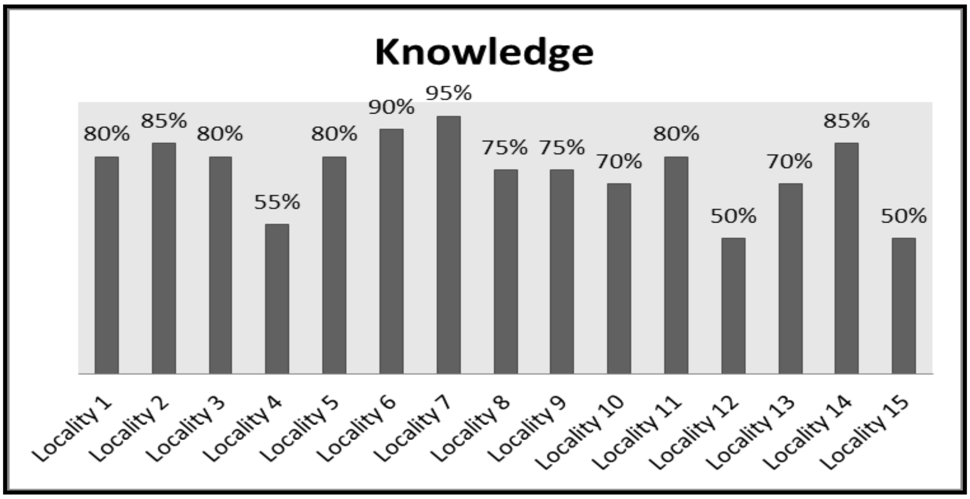
Graph 1 to 4 shows that Knowledge of Earthquake, Causes of Earthquake, Faced Earlier incident by Earthquake, and Resistant Construction building against Earthquake.

Locality 1: -In locality - 1, 80 % of the person having the knowledge of Earthquake, 70% of them know the causes of Earthquake and the entire person having an earlier incident in their life with possible losses. Only 40% of them construct their houses Earthquake resistant and not having proper awareness related to the construction.

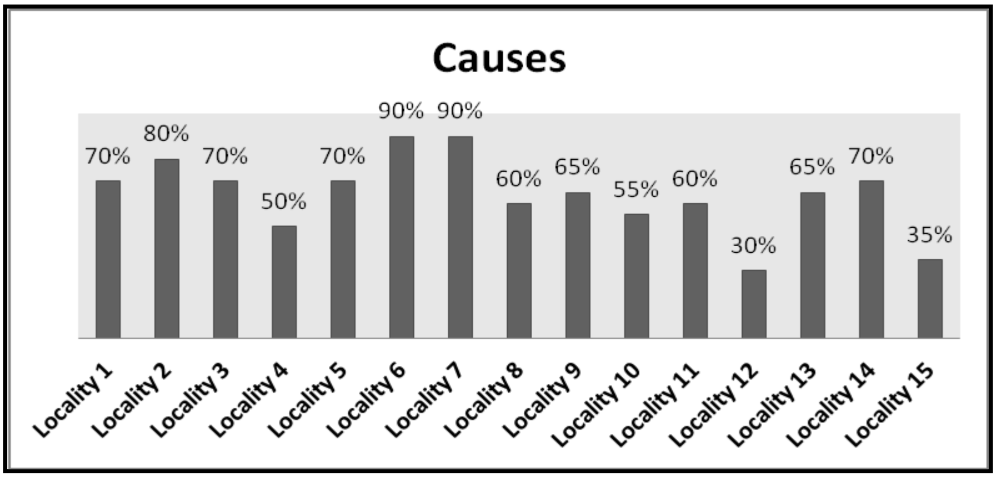
Locality 2: -In the locality - 2, 85% having the knowledge of Earthquake, only 80% know the causes of Earthquake and out of which 95% had faced the earlier incident of the particular disaster with the losses. Only 50% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.

Locality 3: -In locality – 3, 80% persons having the knowledge of Earthquake and only 70% of them know the causes of Earthquake out of which 90% person has an earlier incident in their life with the possible impacts and losses. Earthquake resistant constructions have been done by only 35% person and having little bit awareness.

Locality 4: -In the locality – 4, 55% having the knowledge of Earthquake, only 50% know the causes of Earthquake and out of which 100% had faced the earlier incident of the particular disaster with the losses. Only 20% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.



Graph 1: *Knowledge of Earthquake*



Graph 2: *Causes of Earthquake*

Locality 5: -In locality - 5, 80 % of the person having the knowledge of Earthquake, 70% of them know the causes of Earthquake and the entire person having an earlier incident in their life with possible losses. Only 40% of them construct their houses Earthquake resistant and not having the proper awareness related Earthquake resistant construction.

Locality 6: -In the locality - 2, 90% having the knowledge of Earthquake, only 90% know the causes of Earthquake and out of which 85% had faced the earlier incident of the particular disaster with the losses. Only 65% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.

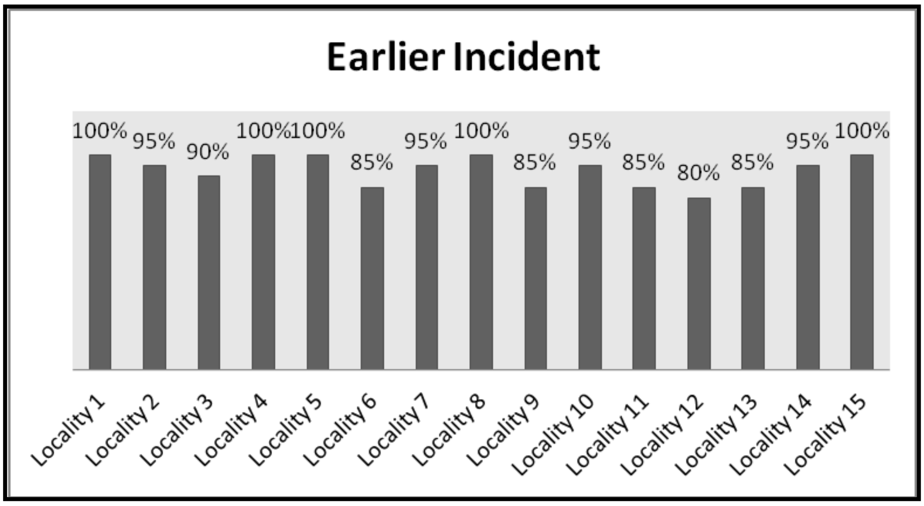
Locality 7: -In locality – 3, 95% persons having the knowledge of Earthquake and only 90% of them know the causes of Earthquake out of which 95% person has an earlier incident in their life with the possible impacts and losses. Earthquake resistant constructions have been done by only 80% person and having satisfactorily awareness.

Locality 8: -In locality - 1, 75 % of the person having the knowledge of Earthquake, 60% of them know the causes of Earthquake and the entire person having an earlier incident in their life with possible losses. Only 30% of them construct their houses Earthquake resistant and not having proper awareness related to the construction.

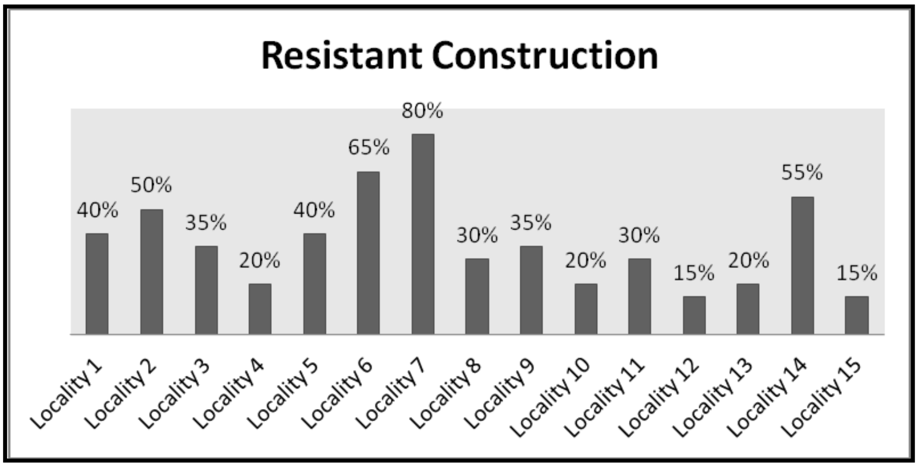
Locality 9: -In the locality - 2, 75% having the knowledge of Earthquake, only 65% know the causes of Earthquake and out of which 85% had faced the earlier incident of the particular disaster with the losses. Only 35% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.

Locality 10: -In locality – 3, 70% persons having the knowledge of Earthquake and only 55% of them know the causes of Earthquake out of which 95% person has an earlier incident in their life with the possible impacts and losses. Earthquake resistant constructions have been done by only 20% person and having little bit awareness.

Locality 11: -In the locality - 2, 80% having the knowledge of Earthquake, only 60% know the causes of Earthquake and out of which 85% had faced the earlier incident of the particular disaster with the losses. Only 30% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.



Graph 3: *Faced earlier incident by Earthquake*



Graph 4: *Resistant Construction, Building against Earthquake*

Locality 12: -In the locality - 2, 50% having the knowledge of Earthquake, only 30% know the causes of Earthquake and out of which 80% had faced the earlier incident of the particular disaster with the losses. Only 15% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.

Locality 13: -In locality – 3, 70% persons having the knowledge of Earthquake and only 65% of them know the causes of Earthquake out of which 85% person has an earlier incident in their life with the possible impacts and losses. Earthquake resistant constructions have been done by only 20% person and having little bit awareness.

Locality 14: -In the locality - 2, 85% having the knowledge of Earthquake, only 70% know the causes of Earthquake and out of which 95% had faced the earlier incident of the particular disaster with the losses. Only 55% of them have constructed Earthquake resistant houses, and remaining not having the awareness and knowledge of resistant construction.

Locality 15: -In locality - 1, 50 % of the person having the knowledge of Earthquake, 35% of them know the causes of Earthquake and the entire person having an earlier incident in their life with possible losses. Only 15% of them construct their houses Earthquake resistant and not having proper awareness related to the construction

6. Conclusion

In modern times rapid urbanization is one of the main reasons which cause earthquakes. Urbanization mainly includes developmental activities and rapid industrialization. These activities weaken the capacity of the earth and rupture the faults by which plates move and cause earthquakes [15]. In present scenario overpopulation is the big problem for the nation, when population increases than their demand increase, but the available space is not adequate in cities which causes overcrowd and congestion in urban areas. It leads to poor infrastructure and cause casualties. The occurrence of the earthquake and its impacts shows that there is a lack of disaster management of particular disaster.

There is a need to spread awareness among the person relayed the causes, impacts and remedies of Earthquake along with the knowledge of Earthquake resistant construction of houses. It serves better life and development of the nation [2]. Government has to provide all the basic facilities and amenities in terms to minimize the loss of earthquake and make local person aware. The conclusion of this work is summarized that the earthquake is very harmful to the living beings as well as non- living beings. It affects life, economy, property etc. And all these losses are due to the unawareness among the people regarding the impact of human activities on the environment and the reverse impact of the environment to the human beings. So disaster management in this respect is the construction of earthquake tolerant or resistant buildings in that particular area. Disaster resistant construction of buildings and houses are the safe and new approaches to reduce the loss of life, economy and property. Disaster Management requires multi-disciplinary and pro-active approach [13]. Besides various measures for putting in place institutional and policy framework, disaster prevention, mitigation initiatives being taken by the Central and State Governments, the community, civil society organizations and media also have a key role to play in achieving our goal of moving together, towards a safer India.

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