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Movement Analysis of Masonry to Construct Earthquake Resisting Structure

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Abstract : There are three basic needs of human beings i.e. food, cloth & shelter. Among third is shelter, this need is fulfill by civil engineers. Due to natural calamities such as tsunami, earthquake etc, the structure get disturb and lead to loss of life & property damage. Earthquake can cause extensive damage to foundation and structures built on them. The effects of an earthquake are mainly viewed with the damages caused to the superstructures of an engineering structure. Most of the structural studies and design advanced thereby deal with earthquake resistant construction of superstructures exclusively.To overcome this issue there is need to construct earthquake resisting structure using various techniques. In this paper focus is made on use of waste product (rubber & plastic footwear) to resist vibration during earthquake. There rubber is waste material, which is used in the wall. Movement analysis has been study with help of sieve shaker instrument which was available in the concrete lab.

Keywords: *Masonry, Rubber, Sieve-shaker.*

1. Introduction

"Unless and until we are able to predict then and than we can save life"

Earthquakes are one of the nature's greatest hazards on our planet which have taken heavy toll on human life and property since ancient times. The sudden and unexpected nature of the earthquake event makes it even worse on psychological level and shakes the moral of the people. Man looks upon the mother earth for safety and stability under his feet and when it itself trembles, the shock he receives is indeed unnerving. Mitigation of the devastating damage caused by earthquakes is of prime requirements in many parts of the world. Since earthquakes are so far unpreventable and unpredictable, the only option with us is to design and build the structures which are earthquake resistant. Accordingly attempts have been made in this direction all over the world. Results of such attempts are very hopeful in developed countries but miserably poor in developing countries including our country India. This is proved by minimal damage generally without any loss of life when moderate to severe earthquake strikes developed countries, where as even a moderate earthquake cause's wide spread devastation in developing countries as has been observed in recent earthquakes. It is not the earthquake which kills the people but it is the unsafe buildings which is responsible for the wide spread devastation. Keeping in view the huge loss of life and property in recent earthquakes, it has become a hot topic worldwide and lot of research is going on to understand the reasons of such failures and learning useful lessons to mitigate the repetition of such devastation. If buildings are built earthquake resistant at its first place (as is being done in developed countries like USA, Japan etc) the devastation caused by earthquakes will be mitigated most effectively. The professionals involved in the design/construction of such structures are structural/civil engineers, who are responsible for building earthquake resistant structures and keep the society at large in a safe environment.

As a multi-disciplinary field of engineering, the design of earthquake-resistant structures is at a threshold from where many exciting developments are possible in the coming years.

1.1 *Concepts for Earthquake Resistant Masonry and Basic Terminology*

The basic principles of design and detailing, as outlined in the codes of practice, of earthquakes resistant structures are intentionally simple and generally easy to adopt. Essentially the principles are focused on,

(i) Achieving strength and ductile behavior
(ii) Maintaining structural integrity

This means that the primary requirement is 'prevention of catastrophic collapse of buildings or their components'. It is also the intention of the codes of practice to achieve this in relatively simple and cost effective manner. The level of resistance aimed for in earthquake resistant design is based on the concept of 'acceptable risk', with the following objectives;
(i) To resist minor earthquakes without damage
(ii) To resist moderate earthquakes without significant structural damage, but with some non-structural damage
(iii) To resist major (or severe) earthquake without major failure of the structural framework
of the building or its components, to prevent loss of life and to allow safe escape passage for the inmates of the building.

However, certain important critical structures hospitals, power generating units, communication set-ups etc., shall be designed to remain operational during and after an earthquake event.

1.1.1 Masonry

Masonry is the building of structures from individual units laid in and bound together by mortar; the term masonry can also refer to the units themselves. The common materials of masonry construction are brick, building stone such as marble, granite and limestone, cast stone, concrete block, glass block. Masonry is generally a highly durable form of construction. However, the materials used, the quality of the mortar and workmanship, and the pattern in which the units are assembled can significantly affect the durability of the overall masonry construction.

1.1.2 Earthquake

Earthquake is defined as a sudden ground shaking caused by the release of huge stored strain energy at the interface of the tectonic plates. An earthquake may be defined as a wave like motion generated by forces in constant turmoil under the surface layer of the earth, travelling through the earth crust. It may also be defined as the vibration, sometimes violent of the earth surface as a result of release of energy in the earth crust.

Earthquake is a physical phenomenon characterized by the shaking of the ground with violent varying intensity. Earthquake starts with an explosion like disturbance somewhere within the outer layer of the crust of the earth. The center of the disturbance is called the focus of the earthquake. An earthquake is an oscillatory movement produced due to release of strain energy below or within the crust of earth surface. It generates elastic vibrations or waves, which moves in all directions from the point of origin and cause earthquake.

Basically, earthquakes are characterized in two ways either source parameter or by visible effects (i.e. intensity). All earthquakes were caused by air or gases struggling to escape from subterranean cavities. Earthquakes are major hazards and can cause catastrophic damage. They have two types of effects direct and indirect. Direct effects cause directly and include ground motion and faulting. indirect effect cause damage indirectly, as a result of the process set in motion by an earthquake. The magnitude and serious implications. The size of an earthquake can be described by the intensity.

1.1.2.1 *Epicenter*

It is the point on the free surface of the earth vertically above the place of origin of an earthquake. The epicenter is the point on the Earth's surface directly above the point where the fault begins to rupture, and in most cases, it is the area of greatest damage. However, in larger events, the length of the fault rupture is much longer, and damage can be spread across the rupture zone. For example, in the magnitude 7.9, 2002 Denali earthquake in Alaska, the epicenter was at the western end of the rupture, but the greatest damage occurred about 330 km away at the eastern end of the rupture zone.

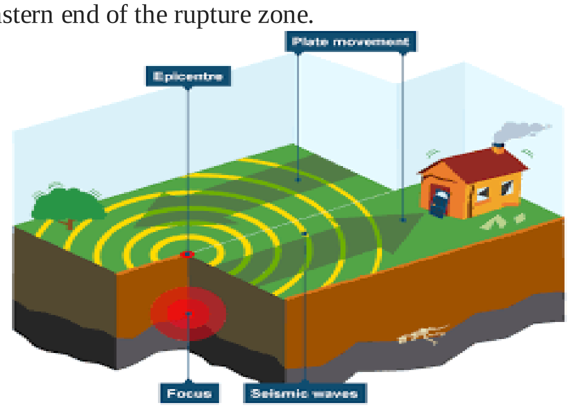

Figure 1

1.1.2.*2 Focus*

It is the point within the earth from where the seismic waves originate. An earthquake's hypocenter is the position where the strain energy stored in the rock is first released, marking the point where the fault begins to rupture. This occurs directly beneath the epicenter, at a distance known as the focal or hypocentral depth.

1.1.2.*3 Focal Depth*

It is the vertical distance between the Focus and the epicenter. The focal depth can be calculated from measurements based on seismic wave phenomena. As with all wave phenomena in physics, there is uncertainty in such measurements that grows with the wavelength so the focal depth of the source of these long-wavelength (low frequency) waves is difficult to determine exactly. Very strong earthquakes radiate a large fraction of their released energy in seismic waves with very long wavelengths and therefore a stronger earthquake involves the release of energy from a larger mass of rock.

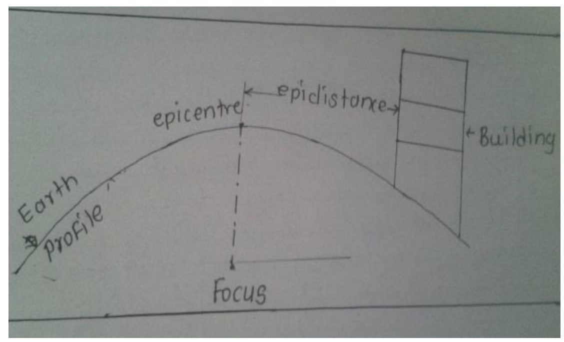

Figure 2

1.2 Literature review

As seen in past records, the construction techniques generally adopted now a days are not so strong to withstand the earthquake pressures coming from earths crust and hence are result into the failures of various building structures. Which is again lead to damage of natural assets, expensive structure, and last but not least precious human life.

After the earthquake at Kathmandu it was seen that mostly there was very less damage in masonry buildings. The completely damaged buildings were the old buildings whereas apartments were moderately damaged which is true according to present code which says structure may get damage but it won’t collapse. Most of the times earthquake takes place in Japan of magnitude ranging 6 to 7 scale. But anyhow the Japanese have managed by constructing earthquake resisting structures which causes very less harm. An earthquake of about 6.3 scale took place in U.S. and there was no harm to human life whereas the same scale earthquake in Latur took the lives of more than 30000 people.

In our country, earthquakes literacy is very low. People in our country do not reach upto the science behind it. Following reasons of building failure were observed during auditing of buildings

1. Too long chajjas are provided.

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2. Columns are broken to construct walls.
3. Columns provided are less than 300mm to match with the walls.
4. Soil testing is not done before construction.

Table 1 U.S. Geological survey

Instr	Acceleration	Velo	Shaking	Damage
1	<0.0017	<0.1	Not felt	None
2-3	0.0013-0.014	1.1	Weak	None
4	0.039	3.4	Light	None
5	0.039-0.092	8.1	Moderate	Very
6	0.092-0.18	17.6	Strong	Light
7	0.18-0.34	31	Very	moderat
8	0.34-0.65	60	Sever	Moderat
9	0.65-1.24	116	Violent	Heavy
10	>1.24	>116	Extreme	Very

2. Experimental program

Masonry is generally highly durable form of construction. In precast structure we get quality control, issue is only of joining the blocks. Hence we made the model in brick masonry. It is very important to note that the first step in masonry building design is to ensure a stable configuration. Masonry structures gain stability from the support offered by cross walls, floors, roof and other elements such as piers and buttresses Load bearing walls are structurally more efficient when the load is uniformly distributed and the structure is so planned that eccentricity of loading on the members is as small as possible. Avoidance of eccentric loading by providing adequate bearing of floor/roof on the walls providing adequate stiffness in slabs and avoiding fixity at the supports etc. is especially important in load bearing walls in multi-storey structures.

Experimental analysis was done to observe the changes in models (model regular & model aanced) by using an sieve shaker. For this analysis we made two models. The models were prepared as follows.

Model Regular

A wall (stretcher bond) of bricks in three layers was prepared. The bricks used were of standard size (19*19*9 cm) & proportion of mortar was 1:6.It was allowed for a curing of three days.

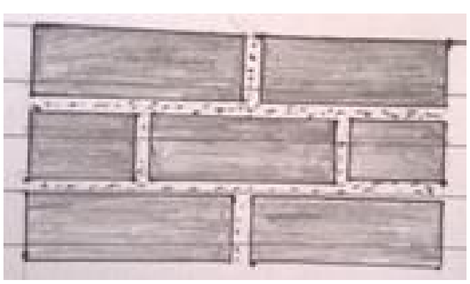

Figure 3 Model Regular

Model Advanced

A hole of size 5 to 6 cm in diameter and 2 to 3 cm in depth was made on opposite side of pit in brick(at base).Whereas a hole of 4 cm diameter & 2 to 3 cm depth is made for half bricks used in bond. These holes are filled with plastic and rubber used in footwear along with concrete with some part of plastic remaining outside the hole as in figure below. A wall (stretcher bond) of these bricks with three layers is made. This model is kept for curing of three days.

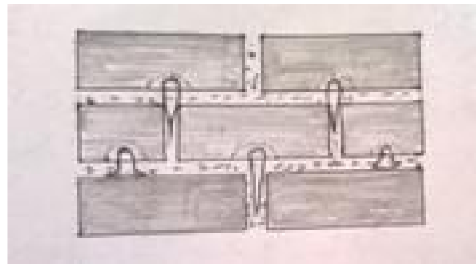

Figure 4 Model Advanced

This models were tested on circular sieve shaker. This vibrator revolves with 1.6 rpm along with an up & down blows of about 125 per minute. Both the models are tested on vibrator one by one. The changes occurring in the model due to vibrations are noted for each second. Having a sturdy cast iron body, the shaker has an inclined sieve table which can accommodate a maximum of seven sieves of 200 mm dia. An adjustable top clamping plate is provided to hold the sieves. The table has a gyratory motion in addition up and down jointing action. Suitable for operating on 220v, 50Hz ,single phase supply.

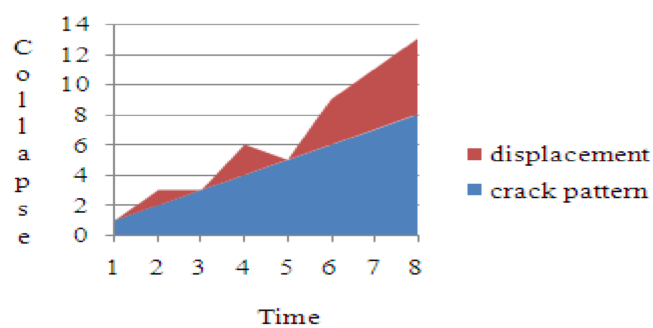

Figure 5 Collapse vs Time (Model Regular)

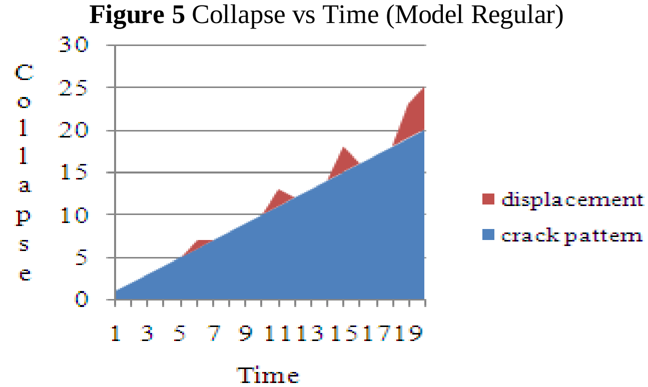

Figure 6 Collapse vs Time(Model Advanced)

Model Regular which was prepared by using only mortar and bricks, collapsed in 7 seconds during testing. Model Advanced which was prepared by using mortar, bricks and rubber, collapsed in 20 seconds during the test.

This values of collapse versus time are based on human observations and may contain minor errors. For more appropriate test values following are the requirements
1. A shake table.
2. High speed camera which captures 1000 frames in one second.
3. Data acquisition system which measures ground acceleration in x, y and z direction.

4. Conclusions

During earthquake maximum movement takes place at top of building. This movement is restricted by the rubber which is provided inside the brick during joining. The rubber dissipates the vibration at bottom and do not let it travel upwards. Rubber absorbs the energy generated in structure due to earthquake.

Technology is available to drastically mitigate the earthquake related disasters. This is confirmed by minimal damage generally without any loss of life when moderate to severe earthquake strikes developed countries, where as even a moderate earthquake cause's huge devastation in developing countries as has been observed in recent earthquakes.The reason being that earthquake resistant measures are strictly followed in these countries where as such guidelines are miserably violated in developing countries. The administration system is efficient and effective in developed countries, and it's not the same in developing countries, so the government should ensure the implementation of earthquake resistant design guidelines. So it is here that civil engineers in general and structural engineers in particular have a great role to play in mitigating the sufferings caused by earthquake related disasters.

Retrofitting should be done in case of old structures. 'Retrofitting' is the term in which the present structure is remodified for resisting earthquakes. However no such certified retrofitting agency is yet into the market.

References

i. *R.S.Khurmi.,J.K.Gupta"Civil engineering"1984 pp-(462-465)*
ii. *Mark Fintel"Earthquake resistance structures"2014*
iii. *S.K.Duggal "Earthquake resistance design of structures" ,2007,pp (1-15).*
iv. *IS: 1905- 1987, "Indian Standard Code of Practice for Structural Use of Unreinforced*
v. *Masonry", Bureau of Indian Standards, New Delhi, India, 3rd Edition, 1987.*
vi. *NDTV(Ndtv/primetime/srikandemanish/jitr)*
vii. *Wikipedia-"Peak ground acceleration" (e.n.wikipedia.org/wiki/peak-ground-acceleration#other-intensityscale)*
viii. *Cassie Mayer "Rubber" 2008,pp (1-2)*
ix. *K.B.Waghulde, Bimlesh kumar,"Vibration analysis of cracked cantilever beam with suitable boundry conditions",IJISET,vol I,2014,pp (20-24).*
x. *Andreas Kappoj,J M Rosset, 1997, chapter-(7)*