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Low Cost Earthquake Resistant Housing Construction in India

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I. ABSTRACT & INTRODUCTION

At least 20,085 people killed, 166,836 injured, approximately 339,000 buildings are destroyed and 783,000 damaged in the Bhuj-Ahmadabad-Rajkot area and other parts of Gujarat. Many bridges and roads damaged in Gujarat. At least 18 people killed and some injured in sourthern Pakistan. Felt throughout northern India and much of Pakistan, also felt in Bangladesh and western Nepal. The earthquake occurred along an apporoximately east-west trending thrust fault at shallow depth. The stress that caused this earthquake is due to the Indian plate pushing northward into the Eurasian plate, complex earthquake; a small event is followed by a larger one about 2 seconds later.

The purpose of this research paper is to present some cost effective solutions for constructing seismic resistant houses in developing countries like india.the paper, first,explores and discuses some of the cost-effective housing construction models that are in practice in different parts of the world. Next the paper identifies techniques and methods for making these buildings earthquake resistant. And finally it recommends some affordable consrtuction methods that are earthquake resistant which might be applicable for cheaper and safe construction.

II. SOME CONCEPTS ON EARTHQUAKE RESISTANT CONSTRUCTION

2.1 Earthquake casualties

Earthquake is a frequent phenomenon in areas called 'earthquake zones'. Earthquakes may create various kinds of casualties like loss of life and damage of property depending upon its magnitude; causalities could range from small property damage to landslides and long range of liquefaction. Secondary effects like fire; blockage on services such as water supply, electricity and transportation; and communication disruption are sometimes even more disastrous. Manmade infrastructures are however the major contributor of casualties during earthquake devastations. These structures therefore should be carefully designed and constructed.

For examples , the improper placement of partition wall, chimney, staircase and how water supply , electrical systems are arranged,are responsible for killing people and in facilitating structural damage to property.

2.2 Reason for buildings' failure during earthquake

(1). The soil fails

Earthquakes move the ground side and up and down-simultaneously. The force behind this movement is powerful enough to turn soft soil instantly into quicksand, eliminating its ability to bear weight. Building constructed on either soft soil or on steeply sloped sites in a seismic zone, therefore, is at special risk. When the shaking finally stops, these buildings are sometimes found slumping into the soil. Taller buildings ar those built of rigid concrete may stay intact but topple over in the unstable soil. Both problems can be directly attributed to soil failure.

(2). The foundation fails

One of several factors that determine a foundations ability to withstand the forces of an earthquake is the buildings mass .all buildings can carry their own weight ;even poorly constructed ones can resist some additional lateral loads, such as those from a normal wind . But buildings are not necessarity designed or constructed to resist the irregular, multidirectional, and intense side-to-side loads that occur during an earthquake, particularly when earthquakes hit in a series of waves. Such is the case during a foundation connection failure, when a building literally slides off its foundation. This kind of failure is an indication that as the foundation was moved by shock waves, a building height also impacts its ability to withstand the forces of an earthquake .the higher the building, the greater it's potential to break apart – especially near the foundation – as it shifts back and forth. The use of ancher bolts to tie the building to its foundation helps prevent the two from separating. Reinforcements to the foundation wall also help to protect against the concentration of shear forces at grade.

(3). A soft floor fails

You've visited them hundresd of times: medical office buildings, hospitals, or other structures constructed at a top of a parking garage or an expansive ground-floor lobby. These lower-level floors are known as soft floors i.e , floors with minimal interior shear walls, additional floor-to-floor height,or large open spaces with concentrations of building mass above.study photographs of older failed buildings and you'll find that the upper levels of a building often remain intact while the lower floors crumble. This is because the concentration of forces is at the ground floor, where most soft floors are located. Wherever they are, however, soft floors represent a break in a building's structural continuity. With fewer walls and little infill, soft floors are typically less rigid than the building constructed on top of them, making soft floors and the columns that support them susceptible to failure in an earthquake.

(4). A building joint fails

A building's shape impacts its ability to resist deflection, and when it comes to shape, most hospitals are not ideal.that's because hospitals typically have irregular shapes, representing multiple additions and expansions made throughout their hitories. The problem, at least with many older buildings, is that newer additions were rigidly connected with the old buildings- even if they were of different heights and construction materials. In older masonry buildings, in fact it's not uncommon to find building expansions that share a common wall with the original structure. If these connections don't accommodate the natural inclination of the different structures to move independently of each other, or if there is insufficient clearance between the different structures, the results can be disastrous in an earthquake.

(5). The building fails

A building's ability to withstand an earthquake also depends on the materials it is made of. Not all building failures result in total collapse. Building failures are also at play when large portions of a roof or façade fall from a building during or after an earthquake. Thesefailures can occur because several diverse building elements have been treated like a single system when, in fact, they should be tied separately back to the structure, with space between them to allow for the differential movements of the dissimilar elements.

2.3 Technolies for earthquake resistance buildings

(1) Structures should not be brittle or collapse suddenly. Rather, they should be tough, able to deflect or deform a considerable amount.

(2) Resisting elements, such as bracing or shear walls, must be provided evenly throughout the building, in both direction side-to-sides, as well as top to bottom.

(3) All elements, such as walls and the roof, should be tied together so as to act as an integrated unit during earthquake shaking, transferring forces across connections and preventing separation.

(4) The building must be well connected to a good foundation and the earth. Wet, soft soils should be avoided, and the foundation must be well tied together, as well as tied to thewall. Where soft soils cannot be avoided, special strengthening must be provided.

(5) Care must be taken that all materials used are of good quality, and are protected from rain, sun, insects and other weakening actions, so that their strength lasts.

(6) Unreinforced earth and masonry have no reliable strength in tension, and are brittle in compression .generally; they must be suitably reinforced by steel or wood.

III. TECHNOLOGY AND PRACTICES FOR LOW COST EARTHQUAKE RESISTANT BUILDING

All traditional earthquake-resistant construction technologies provide the building with the capacity to withstand large earthquake forces without catastrophic collapse.from structural behavior consideration, these technologies can be divided into the following general categories:

(1) Construction technologies using ductile construction materials- such as building made of timber and bamboo.

(2) Construction technologies using robust architecturalforms- such as buildings with symmetric plan and elevation.

(3) Construction technologies using resilient structural configuration –such as buildings with bands and braces.

(4) Construction technologies reducing seismic forces- such as through use of light- weight members.

3.1 Mud walled house

In most of the rural areas of India, rural houses are characterized by mud walled. Sometimes walls are made of sun dried earthen blocks of one to two feet thickness. These mud walled houses are generally oblong in shape and covered with the roofs made with clay tiles, thatch or corrugated iron sheets. The application of these construction materials depends on their availability and the ability of the house owners. In these specific regions the lands are normally above flood level. Besides this, relatively less rainfall, dry climate and lateritic soil (which gets very hard whendry) are the main reasons behind the mud constructions.

3.2 Bamboo walled house

In the piedmont alluvial plains, specially in rangpur , moribund delta area in jessore and haor basins, flood plains of the ganges, the jamuna, the brhamaputra, the meghna, the tista and in some areas in eastern and northern regions, the walls are generally made of bamboo and rooms are configured in rectangular shape. Bamboo is used for making posts and enclosing elements, which is called 'bera' sometimes timber is used for the post and making an upper horizontal floor in the room.

3.3 Timber house

Relatively small groups of populations are using the house forms having walls constructed with timber. Generally, the houses are built on raised wooden platform to get safety from snakes and other animals. The lower parts of the houses are also used for various purposes like storage, keeping domestic animals, different family activities etc.

3.4 Timber and brick built house

The timber and brick built houses are common in India. The floors ,plinths and the lower parts of the walls are constructed with brick while the rest portion of the walls are constructed with bamboo reeds covered with cement or mud on the both sides.

3.5Corrugated iron (C.I) sheet built house

C.I. sheet was not being used as the indigenous building material. Later on, for its durability, it becomes one of the major building materials in local tradition. It is very common to build houses (walls and roofs) with corrugated iron sheets. Corrugated iron sheets are providing protection against rain and dampness of the weather.

IV. RECOMMENDATIONS

Choosing low cost building material does not mean the material will provide poor quality and poor performance during earthquake shakings. Some of the recommendations are-

1. Carry out a site investigation
2. Select a solid site, avoid landfills,flood plains,drainage paths and steep slopes;
3. Position the foundations on rock or firm soil, avoide stepped foundation;
4. Design compact building with a symmetrical shape and closely spaced walls in both directions.
5. Build one –storey houses where possible;
6. Make walls light to reduce the horizontal forces caused by earthquakes;
7. Make roofs light to avoide them pushing walls sideways and falling-in on people;
8. Avoide long walls without intermediate support and tie walls together at the top;

V. CONCLUSION

This paper provides a brief description of the development of indigenous earthquake-resistant technologies in different parts of the world. The paper describes the circumstances leading to their developmentand highlights the ability of ancient cultures and civilizations to collect and process scientific knowledge spanning several generations.

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