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Seismic Analysis of Masonary Building

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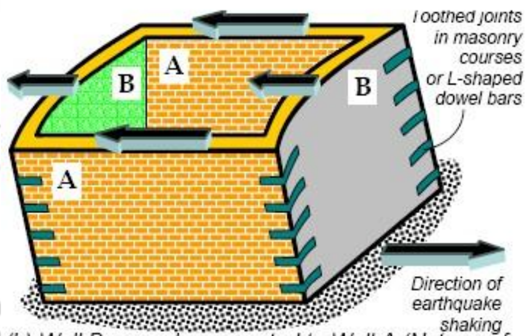
Abstract: ***Masonry buildings are the most common type of construction used for all housing around the world. Masonry buildings of brick and stone are superior with respect to durability, fire resistance, heat resistance and formative effects. Because of the easy availability of materials for masonry construction, economic reasons and merits mentioned above this type of construction is employed in the rural, urban and hilly regions up to its optimum, since it is flexible enough to accommodate itself according to the prevailing environmental conditions. Although this type of construction is most oftenly preferred and most frequently employed yet it is not completely perfect regard to seismic efficiency. The post earthquake survey has proved that the masonry buildings are most vulnerable to and have suffered maximum damages in the past earthquakes. A survey of the affected areas in past earthquakes (Bhuj 2001; Chamoli 1999; Jabalpur, 1997; Killari 1993; Uttarkashi 1991 and Bihar- Nepal 1988) has clearly demonstrated that the major losses of lives were due to collapse of low strength masonry buildings. Thus this type of construction is treated as non-engineered construction and most casualties are due to the collapse of these constructions in earthquake***

Keywords: Masonary Building, Seismic load/demands, Reinforcement

1. Introduction

Occurrences of recent earthquakes in India and in different parts of the world and the resulting losses, especially human lives, have highlighted the structural inadequacy of buildings to carry seismic loads. There is an urgent need for assessment of the building for its present condition of its components and strength of materials.

Further, seismic demand on critical individual components is determined using seismic analysis methods described in IS 1893 (Part1) for lateral forces prescribed for existing buildings in terms of seismic resistance. Masonry buildings in India are generally designed on the basis of IS 1905. The procedure for seismic analysis and design of masonry buildings has still not received adequate attention in India in spite of the fact that single-most important factor of contributing maximum damage and causalities in past earthquake is the collapse of masonry buildings. The aim of this work is to illustrate a simple procedure for design of masonry building. The procedure has been presented by considering each clause as mentioned in IS 1905 and IS 4326:1993 with the help of a work out example of a three storeyed residential masonry building. The procedure is divided into several distinctive steps in order to create a solid feeling and confidence that masonry buildings may also be designed as engineered construction.

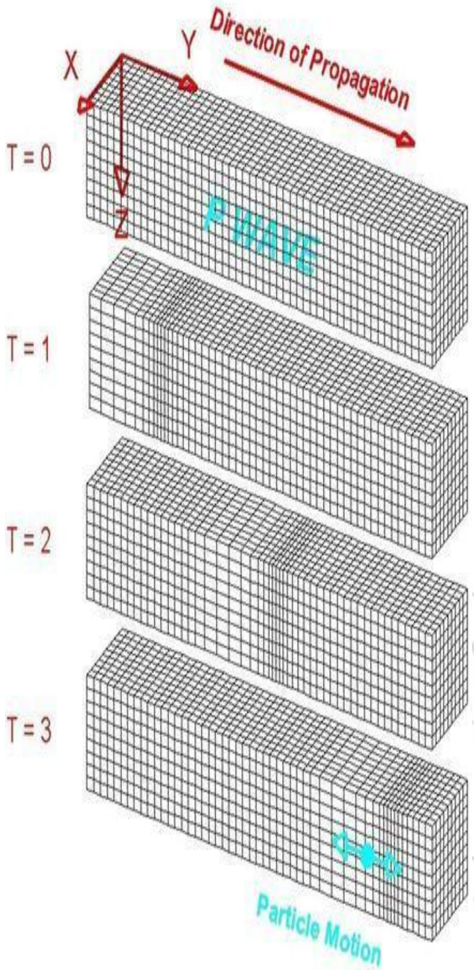


(b) Wall B properly connected to Wall A (Note: roof is not shown): Walls A (loaded in strong direction) support Walls B (loaded in weak direction)

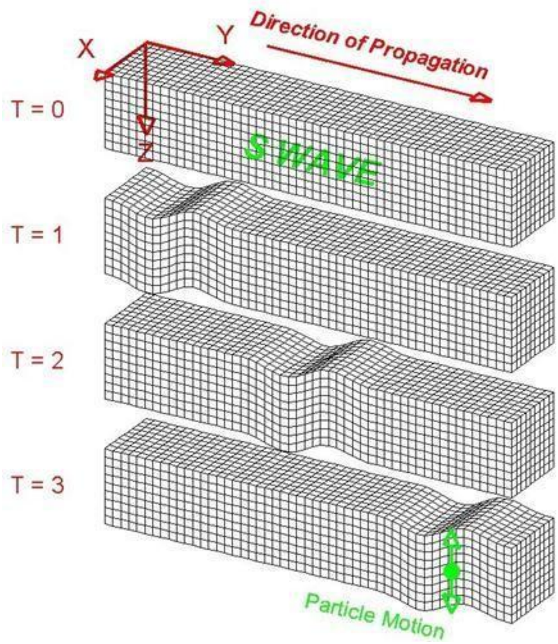
2. Background

The first kind of body wave is the **P wave** or **primary wave**. This is the fastest kind of seismic wave, and, consequently, the first to 'arrive' at a seismic station. The P wave can move through solid rock and fluids, like water or the liquid layers of the earth. It pushes and pulls the rock it moves through just like sound waves push and pull the air. Have you ever heard a big clap of thunder and heard the windows rattle at the same time? The windows rattle because the sound waves were pushing and pulling on the window glass much like P waves push and pull on rock. Sometimes animals can hear the P waves of an earthquake. Dogs, for instance, commonly begin barking hysterically just before an earthquake 'hits' (or more specifically, before the surface waves arrive). Usually people can only feel the bump and rattle of these waves.

P waves are also known as **compressional waves**, because of the pushing and pulling they do. Subjected to a P wave, particles move in the same direction that the the wave is moving in, which is the direction that the energy is traveling in, and is sometimes called the 'direction of wave propagation to see a P wave in action.



The second type of body wave is the **S wave** or **secondary wave**, which is the second wave you feel in an earthquake. An S wave is slower than a P wave and can only move through solid rock, not through any liquid medium. It is this property of S waves that led seismologists to conclude that the Earth's **outer core** is a liquid. S waves move rock particles up and down, or side-to-side-- perpindicular to the direction that the wave is traveling in the direction of wave propagation.



3. Material Used for Study

1. Lintel Band
2. Roof/ Floor Band
3. Vertical reinforcing bar at corner
4. Plinth Band
5. Window Sill Bands

"Equivalent Static seismic forces Procedure "being the simplest method of analysis was adopted to determine the seismic forces. Since the forces depend upon code based fundamental period of structures with some empirical modifier it required less computational effort. The design base shear was computed as a whole, than distributed along the height of the buildings based on simple formulas appropriate for buildings with regular distribution of mass and stiffness. The design Lateral force obtained at each floor level was distributed to individual Lateral.

Load resisting elements depending upon floor diaphragm action. In case of rigid diaphragm reinforced concrete monolithic slab beam floors or those consisting of prefabricated/precast elements with topping reinforced screed was taken as rigid diaphragm action, the total shear in any horizontal plane was distributed to the various elements of Lateral force resisting, system on the basis of relative rigidity

4. Test Program

The seismic weight of each floor was taken as its full Dead Load plus appropriate amount of Imposed Load. While computing the seismic weight of each floor, the weight of columns and walls in any storey was equally distributed to the floors above & below the storey. The weight of Live Load for seismic calculation was taken as zero.

Dead Load and Live load at roof level

The Dead Load and the Live Load at roof level Wr consisted of the sum of (i) Weight of roof, (ii) Weight of walls and (iii) Weight of live load (LL).

DD and LL Load at each storey floor level: The Dead Load and the Live Load at second storey roof level (Wfi) where i is the ith storey consisted of the sum of (i) Weight of floor, (ii) Weight of walls and (iii) Weight of Live Load (LL).

1) Weight of floor was calculated as the product of length, breadth and weight of the floor slab.
2) Weight of walls was calculated assuming half weight of walls at ith storey and half weight of walls at previous storey above which is lumped at roof.
3) Live load is taken according to [IS 875 Part I]

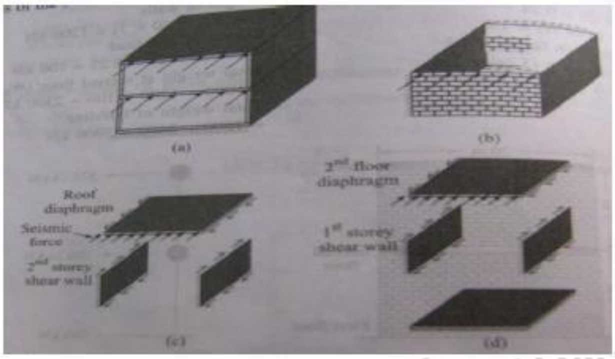
5. Result and Discussion

The mass is lumped in certain points. (At the centre of its floors).

1) The earthquake forces are acting at these masses.
2) The mass of the half of the storey above and half of the storey below is lumped at floor level.

3) The force Qi acting at a floor level is proportional to the lumped mass and the acceleration.
4) The earthquake force is increasing along the height of the building, as the acceleration at floor level is increasing.

The total earthquake force on the building is expressed in terms of base shear VB = which is equal to the sum of all floor loads Qi.
VB = $n\Sigma i=1$ Qi.



Where n is the number of storey.

Lateral force distribution in a box type building (a) Box type masonry building subjected to lateral load (b) Bend of first storey/second storey transverse walls (c) distribution of lateral forces in second storey (d) Distribution of lateral forces in first storey.

A diaphragm may be considered rigid when its midpoint displacement under lateral load is less than twice the average displacements at its ends.

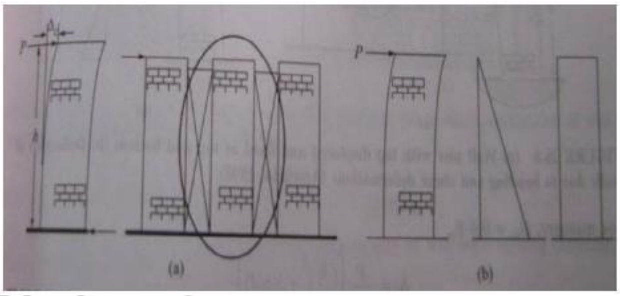
1) Rigid diaphragm distributes the horizontal forces to the vertical resisting elements in direct proportion to the relative rigidities.
2) It is based on the assumption that the diaphragm does not deform itself and will cause each vertical element to deflect the same amount.
3) Rigid diaphragms capable of transferring torsional and shear deflection forces are also based on the assumption that the diaphragm and shear walls undergo rigid body rotation and this produces additional shear forces in the shear wall.
4) Rigid diaphragms consist of reinforced concrete diaphragms, precast concrete diaphragms and composite steel check.

6. Flexible Diaphragm

1) A Diaphragm is considered flexible, when the midpoint displacement, under lateral load, exceeds twice the average displacements of the supports.
2) It is assumed that the relative stiffness of these non-yielding end supports is very great compared to that of the diaphragm.
3) Diaphragms are often designed as simple beams between end supports and distribution of the lateral forces to the vertical resisting elements on a tributary width, rather than relative stiffness.
4) Flexible diaphragm is not considered to be able capable of distributing torsional rotational forces. Flexible diaphragms consist of diagonally sheathed wood diaphragms, etc.

If the pier or wall is fixed only at the bottom and top is free to translate and rotate, it is considered a cantilevered wall. When a force (P) is applied at the top of a pier, it will produce a deflection, , Δc that is the sum of the deflections due to bending moment (Δ'm) Plus that due to the shear (Δv)

Cantilever Pier or wall behavior to deflection



7. Conclusion

The following conclusions are drawn from the present study:

1) The best shapes of earthquake resistant buildings are regular shapes and preferably with two axes of symmetry. This ensures the centre of gravity and rigidity will be the same or close to each other resulting in minimization of torsion moment in building.
2) Provision of bonds at different level increases the number of lateral force and there by reduces the effect of seismic forces remarkably.
3) Provision of vertical reinforcement in flexural walls helps to resist the moments generated due to seismic force. This in turn helps in safe distribution of the lateral load to the shear walls.
4) Provision of vertical reinforcement in shear walls increases the load carrying capacity and the flexural strength of the wall.
5) Vertical steel at walls especially at corners, at openings of shear wall resists the compression and flexure forces helps in preventing sliding or collapse of building
6) A number of construction aspects are required to ensure the box action. Firstly, connections between the walls should be good. This can be achieved by (a) ensuring ood interlocking of the masonry courses at the junctions, and (b) employing horizontal hooks, at various levels, at intersection of the orthogonal walls.
7) The sizes of openings need to be kept small and preferably closer to the centre. The smaller the opening the larger is the resistance offered by the wall.
8) Lastly, the tendency of a wall to topple when pushed in the weak direction can be reduced by limiting its length-to-thickness and height-to-thickness ratio called the slenderness ratio.

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Parvinder kadiyan is currently in final year M TECH Structural Engineering from Samalkha Group of Instutions, Affiliated to Kurukshetra University, Kurukshetra. He did B.TECH in Civil Engineering from RPIT College of Engineering Bastara. Affiliated to Kurekshetra University Kuk.2013 (2009 Batch).He has 1 International Publications. His interested areas of research are, sesmic zones ,earthquake resistant buildings .