comparative analysis of shear wall with waffle slab structure and conventional framed structure

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***Abstract* - From the past records of earthquake, there is increase in the demand of earthquake resisting building which can be fulfilled by providing the shear wall incorporated in building to resist lateral forces produce in plane of wall due to wind, earthquake & other forces. In R.C.C building without shear wall, the beam and column size are quite heavy and there is lot of congestion of reinforcement at the joint and it is difficult to place and vibrate concrete at these places and displacement is quite heavy which induces heavy forces in member. The analysis is by carried out of R.C.C building with different posting of shear wall on floor plan of by using E-TABS software. It gives the idea of analysis of R.C.C building with different configuration. The main objective of earthquake engineers is to design and build a structure in such a way that damage to the structure during the earthquake is minimize. In multistoried buildings flat slab and waffle slab are generally engaged when column spacing is more. Flat slabs and waffle slabs are used in buildings in requirement of more working space like commercial buildings, workshops, assembly buildings, etc. The main disadvantage of structures with flat slab and waffle slab are there lack of withstanding seismic loads. In this paper are presented the aspects of a square shaped waffle slab calculation, supported punctually and having a two-way post tensioning reinforcement disposed parabolically. It is described the waffle slab system, its characteristics, preliminary design of composing elements, technological aspects regarding the manufacturing of precast panels, details regarding used materials, the reinforcement layout and the calculation of prestressing force.**

***keywords* - ETABS 2016, Earthquake, Waffle Slab, Shear Wall, Seismic Analysis, Storey Shear, Storey Drift, Maximum Displacement and Time Period.**

I. INTRODUCTION

A shear wall resists loads parallel to the plane of the wall. Collectors also known as drag member's transfer the diaphragm shear to shear walls and other vertical elements of the seismic force resisting system. Structure Having Shear wall Which Act as a Column to Facilitates High Resistance of Seismic Shears Compare To Column Type Structure. Mainly To avoid the total collapse of the buildings under seismic Force, Shear wall act as a Flexural Stiff Member. Without the Aid of beams, Structure Having Waffle Slab Which To More Suitable For Large Flat Area and Commonly Used in Commercial OR Industrial Buildings. Waffle Slabs Are Resistant to Cracking And Sagging and Can hold a much greater amount of weight than Traditional Flat Concrete slabs.

Shear Wall With Waffle Slab Structure

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are design and constructed properly and they will have the strength and stiffness to resist the horizontal forces. In building construction a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors and roofs to the ground foundation in a direction parallel to their planes. Lateral forces caused by wind, earth quake and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces.

A waffle slab or two-way joist slab is a concrete slab made of reinforced concrete with concrete ribs running in two directions on its underside. The name waffle comes from the grid pattern created by the reinforcing ribs. Waffle slabs are preferred for spans greater than 40 feet (12 m), as they are much stronger than flat slabs, flat slabs with drop panels, two-way slabs, one-way slabs, and one-way joist slabs.

- Cast In situ:
  Formwork construction and pouring of concrete occur on site, then the slab is assembled (if required)
- Precast:
  The slabs are made somewhere else and then brought to the site and assembled.
- Pre-fabricated:
  The reinforcements are integrated into the slab while being manufactured, without needing to reinforce the assembly on site. This is the most expensive option.

Fig. 1 Shear wall structure

Fig. 2 Waffle Slab Structure

II. REVIEW OF LITERATURE

Anurag Sharma et al[1] studied multistoried buildings flat slab and waffle slab are generally engaged when column spacing is more. Flat slabs and waffle slabs are used in buildings in requirement of more working space like commercial buildings, workshops, assembly buildings, etc. In this paper, an attempt has been made to investigate the seismic effect on multi storey building of G+9, G+14 and G+19 floors with waffle slab and flat slab using the software ETABS 2013. They have concluded that, Results From that above Graphs analysis, it can be said that the maximum displacement value of flat slab is about 16% higher compared to waffle slab in both X and Y direction for G+9 storey building. In G+14 storey building, maximum displacement value of waffle slab is 89% higher compared to flat slab in X direction whereas in Y direction it increases upto 86%. In G+19 storey building, maximum displacement is constant in both flat and waffle slab in both X and Y direction with a slight variation.

Shruthi K Chandran et al[2] present construction practice flat slab systems has become widely used in reinforced concrete buildings. In RC buildings flat slab system exhibit several advantages over conventional moment resisting frames. Shear walls are used to resist lateral forces parallel to the plane of the wall. Large forces are generated due to seismic action resist by high in plane stiffness and strength of shear wall. Mainly to avoid the total collapse of the buildings under seismic forces, shear wall act as a flexural member. In this paper, study of 14 storey building in zone IV is considered, and is analysed with flat slab by changing various shapes of shear wall to determine different parameters like storey shear, storey displacement, storey drift and time period. Analysis is done using ETABS V.16.Software. They have concluded that according to the earthquake code book IS 1893[PART I] 2002 and analysis is carried out by taking regular plan of building [G+14] on medium soil [TYPE II] and ZONE IV is done by linear dynamic with different shear walls.

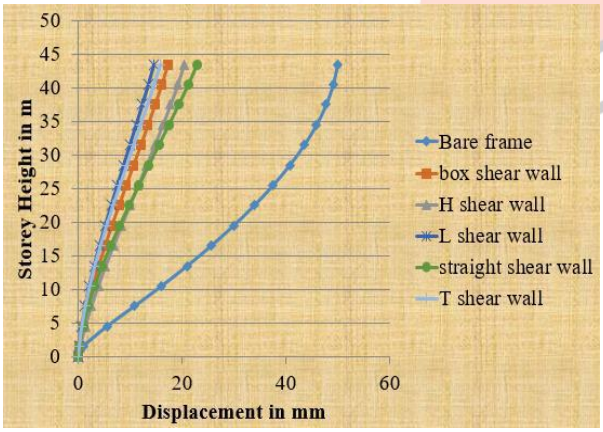

Fig 3. Results of Storey displacement

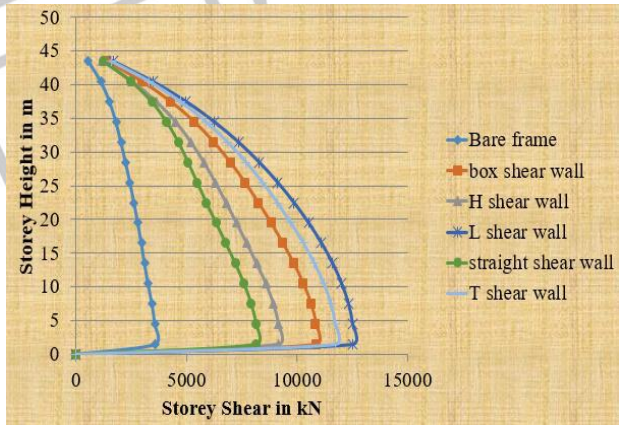

Fig 4. Results of Storey shear

Agrawal and Charkha[3] Are investigation reveals that the significant effects on deflection in orthogonal direction by the shifting the shear wall location. Placing Shear wall away from center of gravity resulted in increase in most of the members forces. Multistorey buildings are adequate for resisting both the vertical and horizontal load. When such building is designed without shear wall, beam and column sizes are quite heavy and there is problem arises at these joint and it is congested to place and vibrate concrete at these places and displacement is quite heavy which induces heavy forces in building member. Shear wall may become essential from the point of view of economy and control of horizontal displacement.

Chandurkar and Pajgade[4] Are investigated Changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake.

K. Saketh et al[5] presents the information of behaviour punching shear in waffle slabs at slab-column joint subjected to concentric punching shear. Although it was observedthat waffle slabs are very similar to that of flat slabs, the shear capacity is

relatively reduced because some of the potential surfaces is lost when it extends into waffle section. The current IS code of practice do not consider the punching shear mechanism of waffle slabs. The analytical part is done using Finite Element software ANSYS, by applying the concentric load at the slab-column joint on waffle slabs, waffle slabs of different sizes and comparing the analytical results with normal RC slab. The increase of solid portion and spacing between ribs for model 5 also gives more strength to the waffle slab but ultimately the increase of rib width proves to be achieving more strength.

Shubham Kasat et al[6] took From the past records of earthquake, there is increase in the demand of earthquake resisting building which can be fulfilled by providing the shear wall incorporated in building to resist lateral forces produce in plane of wall due to wind, earthquake & other forces. In R.C.C building without shear wall, the beam and column size are quite heavy and there is lot of congestion of reinforcement at the joint and it is difficult to place and vibrate concrete at these places and displacement is quite heavy which induces heavy forces in member.

T.Shobha et al[7] shows the Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically from a box which provides all of the lateral support for the building. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces. In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. As per their design by hand in the corner reinforcement of the shear wall of 25 meters is to be provided with 20 mm bars of 20 in numbers and the middle area is provided with 12 mm bars with 300 mm spacing in vertical directions and 450 mm spacing in horizontal direction for 309 mm wall. The values in the computer design also matched the theoretical design. It is estimated that whenever an opening is expected the bar diameter is increased and lateral ties are provided inside the wall to replicate lintel beam in the wall for extra stability.

III. CONCLUDING REMARK

After the deatailed review paper, following are the conclusion taken in this paper.

- ✓ The bare frame gives more displacement, time period and storey drift compared to other shapes of shear wall. Hence, the presence of shear wall is possible of controlling the damage that may occur due to earthquake force.
- ✓ Time period comparison gives the L shaped shear wall is better shape than others.
- ✓ From the comparison of storey displacement values L shaped shear wall indicate lesser displacement and then better one is straight shear wall.
- ✓ Storey displacement value obtained from the analysis indicates that L shape obtained least value then better one is T shaped shear wall.
- ✓ Storey shear maximum for L shaped and T shaped.
- ✓ Structure with L shaped shear wall is suitable for the effect of earthquake load on the performance of building.
- ✓ It is observed that waffle slabs are advisable for structure with a height less than 40m, whereas for structures of height above 40m it is advisable to go with flat slab.

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