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DESIGN AND CONSTRUCTION OF SHEAR WALLS

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ABSTRACT:

Constructions made of shear walls are high in strength, they majorly resist the seismic force, wind forces and even can be build on soils of weak bases by adopting vari- ous ground improvement techniques. Not only the quick- ness in construction process but the strength parameters and effectiveness to bare horizontal loads are very high. Shear walls generally used in high earth quake prone ar- eas, as they are highly efficient in taking the loads. Not only the earth quake loads but also winds loads which are quite high in some zones can be taken by these shear walls efficiently and effectively. Shear walls have a peculiar behavior towards various types of loads. Calculation of rigidity factor, reactions, shear center, shear force and bending moment is a topic of interest. To determine the solution for shear wall location in multi-storey building based on its both elastic and elas- to -plastic behavior's. The earthquake load is to be calcu- lated and applied to a multistoried building. Model results are calculated and analyzed for the effective location of shear wall. Hence by adopting the shear wall technolo- gies to the college building of VITS block, Deshmukhi Hyderabad city. The building behavior is checked. The design is above verified for this same structure using extended three dimensional analysis of buildings (STAAD Pro V8i) software.The results are compared. It is found that the provision of shear wall in this building will make this structure completely earth quake resistant in zone II of Hyderabad. Further it is also found that the results of manual and STAAD Pro are almost same, the STAAD Pro giving a little bit of saving in the reinforcement quantity.

Keywords: STAAD.Pro, Earth Quake Loads, Shear Walls, IS: 1893, IS:456-2000.

INTRODUCTION:

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 residen- tial 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 designed and constructed properly, they will have the strength and stiffness to resist the horizontal forces. Shear walls are one of the most effective building elements in resisting lateral forces during earthquake. By constructing shear walls damages due to effect of lateral forces due to earth- quake and high winds can be minimized. Shear walls con- struction will provide larger stiffness to the buildings there by reducing the damage to structure and its contents. In building construction, a rigid vertical diaphragm ca- pable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-con- crete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attach- ing or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces.

In the last two decades, shear walls became an important part of mid and high-rise residential buildings. As part of an earthquake resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. So shear-wall frame structures are obtained.Shear wall buildings are usually regular in plan and in elevation. However, in some buildings, lower floors are used for commercial purposes and the buildings are characterized with larger plan dimensions at those floors. In other cases, there are setbacks at higher floor levels. Shear wall buildings are commonly used for residential purposes and can house from

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100 500 inhabitants per building.

2. PURPOSE OF CONSTRUCTING SHEAR WALLS:

Shear walls are not only designed to resist gravity / verti- cal loads (due to its self-weight and other living / mov- ing loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three di- mensional stability for the building structures. Shear wall structural systems are more stable. Because, their support- ing area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building.

3 COMPARISONS OF SHEAR WALL WITH CONSTRUCTION OF CONVENTIONAL LOAD BEARING WALLS:

Load bearing masonry is very brittle material. Due to dif- ferent kinds of stresses such as shear, tension, torsion, etc., caused by the earthquakes, the conventional unreinforced brick masonry collapses instantly during the unpredict- able and sudden earthquakes. The RCC framed structures are slender, when compared to shear wall concept of box like three-dimensional structures. Though it is possible to design the earthquake resistant RCC frame, it requires extraordinary skills at design, detailing and construction levels, which cannot be anticipated in all types of con- struction projects. On the other hand even moderately designed shear wall structures not only more stable, but also comparatively quite ductile. In safety terms it means that, during very severe earthquakes they will not sud- denly collapse causing death of people. They give enough indicative warnings such as widening structural cracks, yielding rods, etc., offering most precious moments for people to run out off structures, before they totally col- lapse. For structural purposes we consider the exterior walls as the shear-resisting walls. Forces from the ceiling and roof diaphragms make their way to the outside along assumed paths, enter the walls, and exit at the foundation.

4.FORCES ON SHEAR WALL:

Shear walls resist two types of forces: shear forces and uplift forces. Shear forces are generated in stationary buildings by accelerations resulting from ground move- ment and by external forces like wind and waves. This ac- tion creates shear forces throughout the height of the wall between the top and bottom shear wall connections.Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Uplift forces are greater on tall short walls and less on low long walls. Bearing walls have less uplift than non-bearing walls because gravity loads on shear walls help them resist uplift. Shear walls need hold down de- vices at each end when the gravity loads cannot resist all of the uplift. The hold down device then provides the nec- essary uplift resistance.

Shear walls should be located on each level of the struc- ture including the crawl space. To form an effective box structure, equal length shear walls should be placed sym- metrically on all four exterior walls of the building. Shear walls should be added to the building interior when the exterior walls cannot provide sufficient strength and stiff- ness. Shear walls are most efficient when they are aligned vertically and are supported on foundation walls or foot- ings. When exterior shear walls do not provide sufficient strength, other parts of the building will need additional strengthening. Consider the common case of an interior wall supported by a sub floor over a crawl space and there is no continuous footing beneath the wall. For this wall to be used as shear wall, the sub floor and its connections will have to be strengthened near the wall. For Retrofit work, existing floor construction is not easily changed. That's the reason why most retrofit work uses walls with continuous footings underneath them as shear walls.

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5. CLASSIFICATION OF SHEAR WALLS:

•Simple rectangular types and flanged walls (bar
•Coupled shear walls
•Rigid frame shear walls
Framed walls with in filled frames
•Column supported shear walls
•Core type shear walls

METHODS OF DESIGN OF SHEAR WALL:

There are three types of design methods
(a) Segmented shear wall method
(b) Force transfer –ground openings method
(c) Perforated shear wall method

TYPES OF SHEAR WALLS:

1. RC Shear Wall 2.Plywood Shear Wall
3. Midply Shear Wall
4. RC Hollow Concrete Block Masonry Wall
5. Steel Plate Shear Wall

6. DESCRIPTION OF THE BUILDING:

The building we considered is C-Block of vignan institute of technology and science, an Engineering college located at deshmukhi village, Rangareddy district, the college of- fers courses in civil, mechanical ,electronics and commu- nication ,electrical and electronics ,computer sciences en- gineering with an intake of about 1000 students per year. This block consists of 3 bays of 20m width and 4 m height of 3 floors .the ground floor consists of one laboratory covering an area of 3 bays and the remaining floors G+1 and G+2 consists of 6 Class rooms. And the walls are of 0.3m thick .The walls between central bays are designed as shear walls as shown in figure. It shows the layered structure of the curre

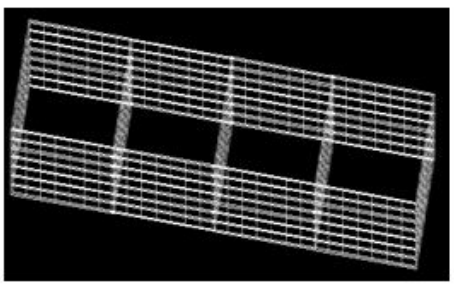

Fig: 1 Layered Structure of Current Building

SHEAR WALLS:

The shear walls are proposed to be inserted in the C-Block Building and the analysis and design of the building with the shear walls is done with staad Pro and manually .The shear walls will be designed to resist the lateral forces developed due to earthquake and wind loads .The shear walls are proposed to be located at the centre and shear walls are proposed in 8 bays, Each bay 20 m width, 4 m height. Total shear wall Area is 640square meters. Thick- ness of shear wall is thickness of conventional wall which is 0.3 m. The location of shear walls is shown in Figure.

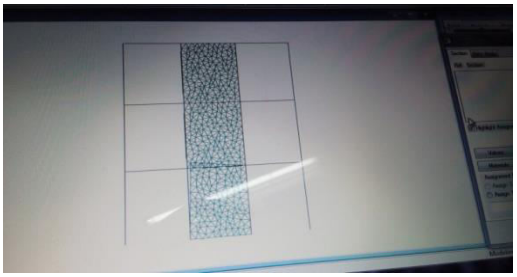

Fig: 2 locations of shear walls

NECCESITY OF SHEAR WALLS TO THE PRESENT BUILDING:

As already explained the building is often subjected to vibrations produced from the nearby quarrys and more- over it is on hills which are more prone to earthquakes
. If at all any earth quake occurs huge life and property loss may occur .So, it is being necessary to take precau- tions against vibrations caused due to bomb blasts from the quarry and also against natural disasters .Shear walls are the easiest ways to provide resistance to vibrations and very easy to design .

Here in our study we are taking the c block of vignan col- lege and locating and designing shear walls for the exist- ing structure. The 3-D view of shear walls in the building is shown in Figure.

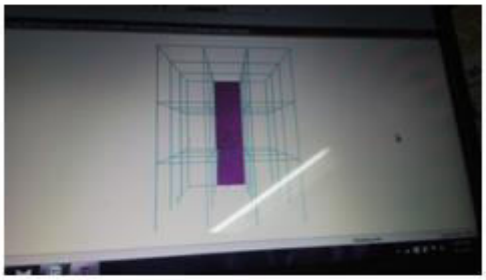

Fig: 3 3D Views of Shear Walls in the Building

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Fig: 4 3D Views of Shear Walls in the Building

7. STAAD PRO –AN OVERVIEW:

STAAD.Pro V8i is a comprehensive and integrated fi- nite element analysis and design offering, including a state-of-the-art user interface, visualization tools, and in- ternational design codes. It is capable of analyzing any structure exposed to static loading, a dynamic response, wind, earthquake, and moving loads. STAAD.Pro V8i is the premier FEM analysis and design tool for any type of project including towers, culverts, plants, bridges, sta- diums, and marine structures.With an array of advanced analysis capabilities including linear static, response spectra, time history, cable, imperfection, pushover and non-linear analyses, STAAD.Pro V8i provides your en- gineering team with a scalable solution that will meet the demands of your project every time. in Asia – STAAD. Pro V8i is the perfect workhorse for your.

Surface number	1	2	3	4	5	6	7	8
Shear force x	1.3672	0.0003	0.0037	1.367	0	0	1.3672	-0.0003
Shear force y	0.0008	0.0038	-0.1229	0	0.0043	0.0043	0.0008	0.0039
Shear force z	0.2218	0.0039	2.6438	0	3.8939	3.8939	0.2218	3.8104
Bending moment-X	0.0002	0.0003	0.0004	0	0.0038	0.0038	0.0002	0.0038
Bending moment-y	0.0006	3.8104	0.0375	0.0005	0	0	0.0006	0.0003
Bending moment-z	0.0009	0	-0.0008	0.001	0	0	0.0009	0

8. RESULTS AND ANALYSIS:

The c block in vignan college building is designed using staadpro software.All the columns ,beams and shear walls are designed using this soft ware.The shear walls are de- signed manually also.The block consists of 3 floors and 3 bays in each floor.Shear walls are designed for earthquake loads, dead loads and live load for a college building as per Indian standard code .Wind loads vary with the place ,type of soil and type of buildings considering all the con- ditions appropriate loading is given .The Design and re- sults of the building are detailed in the output obtained from staadpro software. shear force and bending moment variations and reinforcement details of shear walls for the 8 bays are described here.

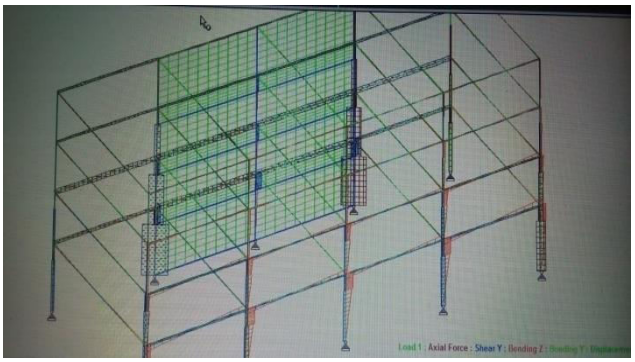

Fig: 5 shows the general dimensions of beams, columns and shear walls

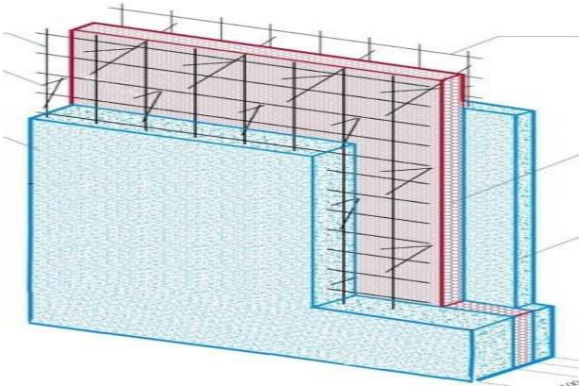

Fig: 6 Figure of Single Shear Wall.

SHEAR FORCES AND BENDING MOMENT VARISTION IN ALL SHEAR WALL SUR- FACES OBTAINED IN THE RESULTS

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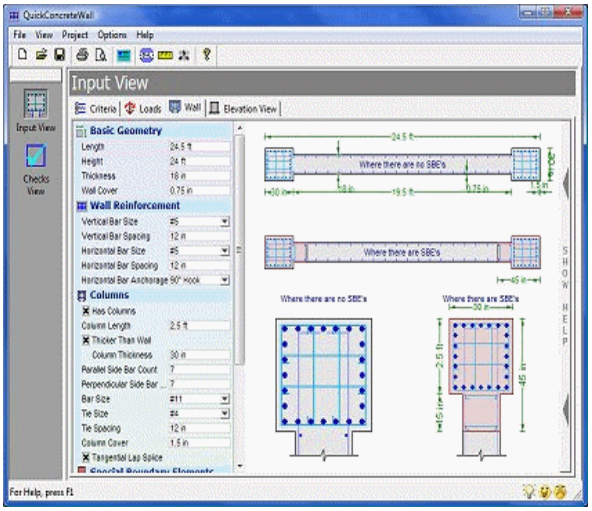
FUTURE SCOPE OF WORK:

Construction of shear walls gives all time protection for the building not only while the times of earthquakes but also against vibrations created by blasts in quarry's and also even if the capacity of the build- ing is to be increased shear walls give enough strength and can confidently raise the building to another floor Shear walls are considered to be a gift to the future con- struction industry. Scope of shear walls in construction field is immense. It's since their arrival in market there topic was always a topic of interest. Shear walls are the structures usually build to balance lateral loads acting on the structure. Where the lateral loads are most predomi- nantly wind and earth quake loads. And predominantly earthquake loads are more intense in their effect on the building structures. Earthquakes are becoming more in- tense due to the key reason that is ground water depleash- ement. Hence in order to overcome the



diverse effects of earthquake its always best to save ourselves from future disasters. Shear walls are quick in construction, as the walls doesn't need any special brick Arrangement or plastering they are very quick in their construction. It just requires an effec- tive form work and very little skilled labor. It was estimat- ed that a 20 floors building can be built within six months which is most astonishing. Therefore there is lot of scope c)expected the bar diameter is in- creased and lateral ties are provided inside the wall to rep- licate lintel beam in the wall for extra stability

for future study in shear walls. The shear walls can be designed and provided for the existing buildings having more than 3 floors. Further various design methods of shear walls can be studied.The various shapes of shear walls can be studied.Different locations can be studied. Provision of shear walls with different materials can be studied.

CONCLUSIONS :

The provision of shear walls in C-Block Building of the college in the indicated locations will take care of earth quake load and make the building earth quake resistant The thickness and the reinforcement considered and pro- vided for the shear walls could be sufficient to take care all types of loads developed due to earthquake.The col- umns, Beams, Slabs of the Buildings is also analyzed with Staad Pro and it is found that the existing dimensions and reinforcement are sufficient to take care of the strength re- quirements developed due to dead load, seismic load and live load.A comparison of Manual design and computer- ized design indicates the following .

a)As per our manual design we used IS code 1893:2000 and the design results for the shear walls are The corner reinforcement of the shear wall of 20 meters is to be pro- vided with 16 mm bars of 20 in numbers, and the middle area is provided with 10 mm bars with 150 mm spacing in vertical direction and 150 mm spacing in horizontal direction for 300 mm wall.

b) As per our computerized design we used the same code and the results areThe corner reinforcement of the shear wall of 20 meters is to be provided with 16 mm bars of 20 in numbers, and the middle area is provided with 10 mm bars with 140mm spacing in vertical direction and 120 mm spacing in horizontal direction for 300 mm wall. The values in the computer design also almost matched the theoretical design the slight variation may be due to accuracy of computerized method. It is estimated that whenever an opening is

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