Analysis of earthquake resisting building with Shear wall using ETABS Software

Saud Anjum Mahevi[1], Aadil S Ansari[2], Naveed Akhtar[3], Faizan Ahmed[4], Md. Nasiruddin[5]

[1, 3, 4](Department of Civil Engineering, MMANTC/ SPPU, India)
[2](Department of Computer Engineering, MMANTC/ SPPU, India)
[5](Department of Mechanical Engineering, MMANTC/ SPPU, India)

Abstract: *After food and clothing, shelter is a basic human need. To meet the food and clothing requirements of vast population India became successful; however the problem of providing shelter of all is defying solutions. "A large gap still exists between the demand and supply of housing units, while there has been an impressive growth in the total housing stock from 65 million in 1947 to 187.05 million in 2001,. The Working Group on Housing for the 9th five-year plan estimated the housing shortage in 2001 at 19.4 million units- 12.76 million in rural area and 6.64 million in urban area. The shortage of housing is acutely felt in urban areas –more so in the 35 Indian cities, which according to the 2001 census have a population of more than a million". Shear walls constructions are of high in strength, which resist the seismic force, wind forces and even can be built on soils of weak bases by adopting various ground improvement techniques. Not only the construction process is fast but also the strength parameters and effectiveness to bare horizontal loads is very high. Shear walls generally used in high earth quake prone areas, as they are highly efficient in taking the loads. Wind load and the earthquake are quite high in some zones, it can be taken by these shear walls efficiently and effectively.*
Keywords: *Construction, Earth quake, Human needs, Population, Shear wall.*

I.   Introduction

Shear walls are vertical elements of the structure to resist the horizontal force.Shear walls are constructed to counter the effects of lateral load acting on a structure. Shear walls are straight external walls that typically form a box in residential construction which provides all the lateral support. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces[1].

Aninflexiblevertical diaphragm in building constructionare competent 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-concrete wall or vertical truss. The uneven settlement loads, due to the weight of structure and occupants; create powerful twisting (torsion) forces because of lateral forcesof wind and earthquake. These forces can exactly tear (shear) a building apart. By placing of reinforcement frame in a rigid wall, maintains the shape of the frame and prevents rotation at the joints. Shear walls are important in tall buildings subjected to lateral wind and seismic forces

In previous two decades, shear walls became an important part of mid and high-rise residential buildings. Being a part of earthquake resistant building design, shear walls are placed in building plans reducing lateral displacements under earthquake loads[2]. So shear-wall frame structures are obtained. In plan and in elevation shear wall buildings are generally regular. In whatever way, some of the buildings lower floors are used for commercial purposes and characterized with larger plan dimensions. In some cases, there are setbacks at higher floor levels. Shear wall buildings are commonly used for residential purposes and can house from 100 to 500 inhabitants per building[3].

1.1 Objectives
1.1.1 Shear walls are not only designed to resist gravity or vertical loads, but they are also designed for lateral loads of earthquakes / wind.
1.1.2 The walls are structurally integrated with roofs, thereby giving the three dimensional stability for the building structures.
1.1.3 Shear wall structural systems are more stable.
1.1.4   Shear walls are quick in construction.

II.   Methodology

Firstly click on the ETABS icon. A window appears which shows a different tip every time you open the software.

This window provides us 3 options. You can click on previous or next tip to checkout some more tips or else click ok to move further.

As per your convenience change the units at the right bottom to KN-m or any other.

To create a new file or to open an already existing file click on file option

Another window will appearwhen you open a new file which again contain 3 options

- choose. edb

- Default. edb and then No
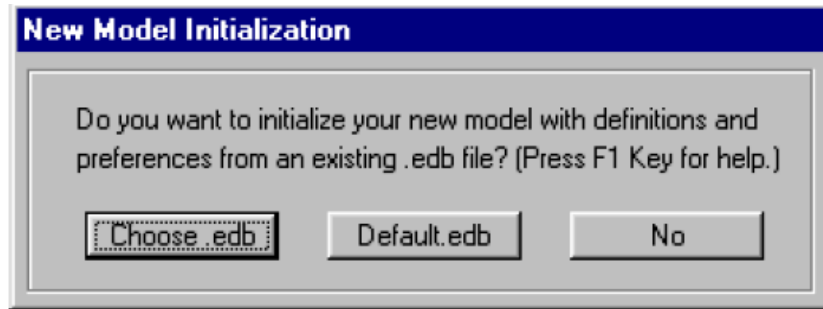
Fig.1 New model selection

1st option helps us to select an already existing file.

2ndoption helps us to create a new file and

3rddisplays the grid data and story data.

To create a new file, click on default. edb

A new window will open which showsStory data, building plan and grid system. In the option of grid dimensions we can either select uniform spacing or customize the grid spacing. We have to give no of lines in x direction and y directions as per the columns and beams used in the plan.
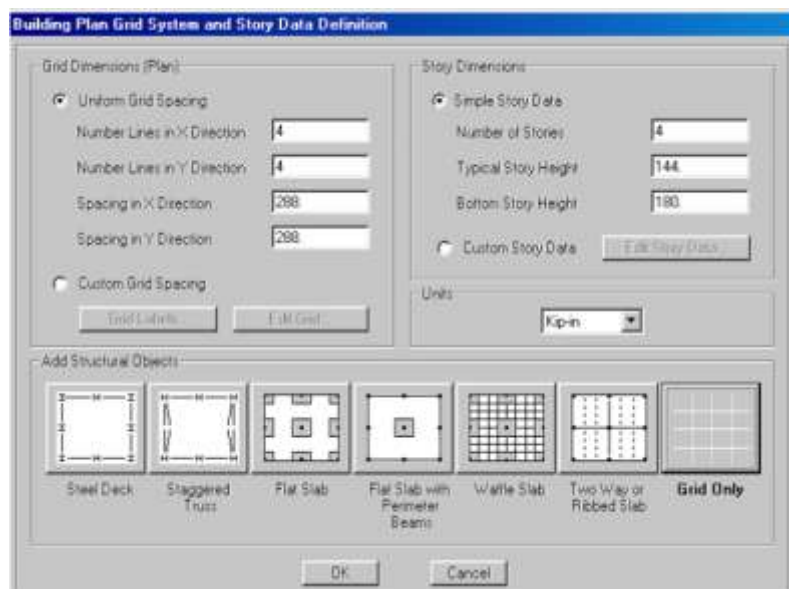

Fig.2 Provision of storey and grid data

Story dimensions consist of simple story data and custom story data. Simple story data make use of the defaults or specify values for the typical story height, number of stories and bottom story height. For all stories in the model the value specified for the typical story height will be used, other than the bottom story,we can manually define story names in custom story data, story similarity,andstory levels of non-uniform height.

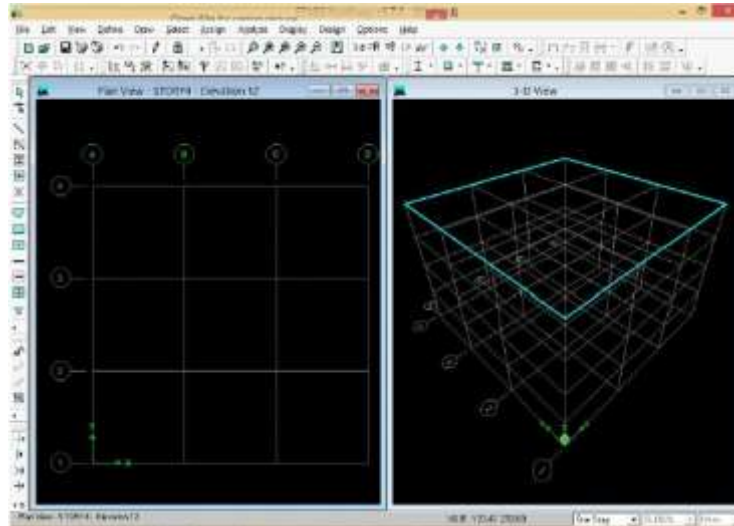Click on grid only in structural objects after giving the entire data and then click on ok.

Fig.3 ETABS main window

Now the screen will be divided into two equal parts, one is plan-view and other is 3-D view of the given data.

We can adjust the view options to plan 3D or elevation views and we can choose any of the stories as per the work to be done on that particular story. We change the story options to either similar or all stories at the right corner of the window. This makes us to save time i.e.As per the option selected if we are working on a specific story, then that is transferred to remaining stories or similar stories. The top story is selected as default story.

After providing the entire grid data and story data, we have to define the properties of the material that is used.

To define a material property, select define=>material properties. It gives us to add new material, modify or delete an existing material. Now Click on add new material to produce a new material with required properties.

1st provide a grade (say M20, M30 etc.) and then provide other properties of the material such as weight per unit volume, mass per unit volume,Poisson's ratio elastic modulus,. The other design properties which are to be provided that mean characteristic compressive strength and yield strength values. You have other options such as change in display color, type of material which is always isotropic. Click on ok after the entire data is provided.

The next step is to create beams and columns. To produce a beam or column, first click on define=>frame sections command. In this display we have to import and add options further provided with modify or delete options of already existing properties.
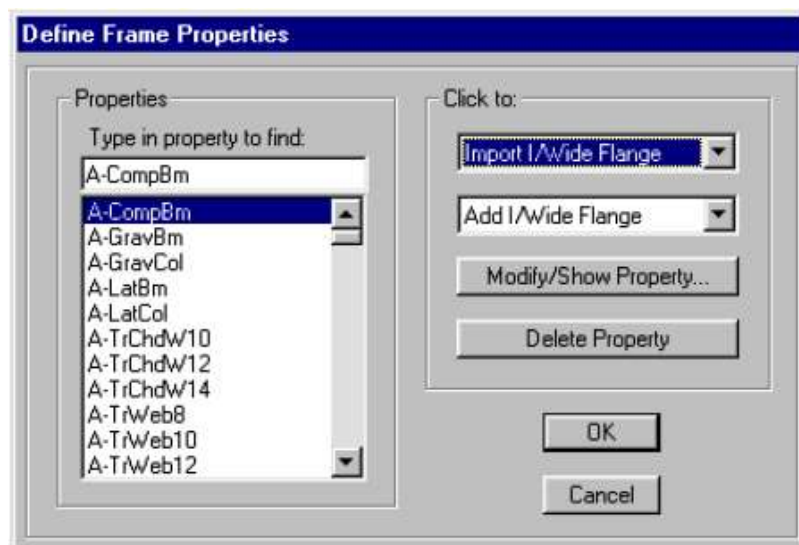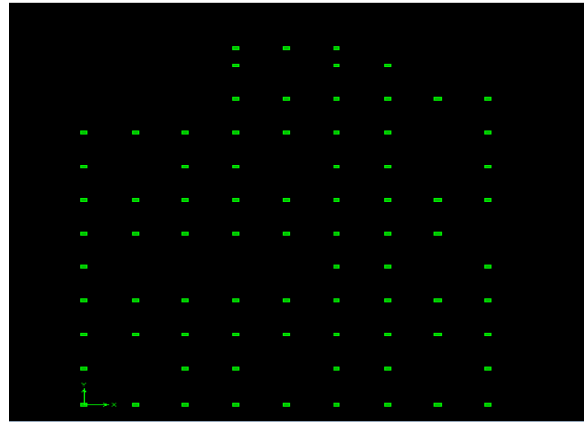

Fig.4Addition of frame sections

2.1 Marking of columns, beams:

To produce a column, by doing the above process is again and again the only difference is the reinforcement data which is stated earlier both for beams and columns.


Fig.5- Columns of the Civil block

To create a beam, directly click on the icon create lines or region at click. Another way to do it is to click on Draw menu=>Draw line objects=>Create lines or regions on click command. A window appears which provides properties of the object in which the property is changed to the beam that we defined earlier. We can directly selectall at once or click on each grid point and the beams are assigned to the grid.
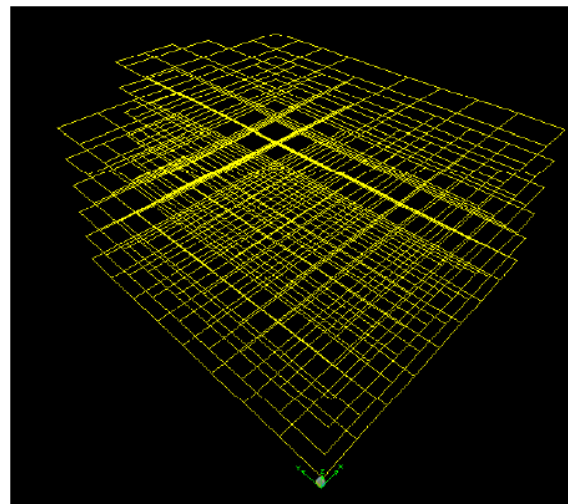
Fig.6 Beams of the civil block
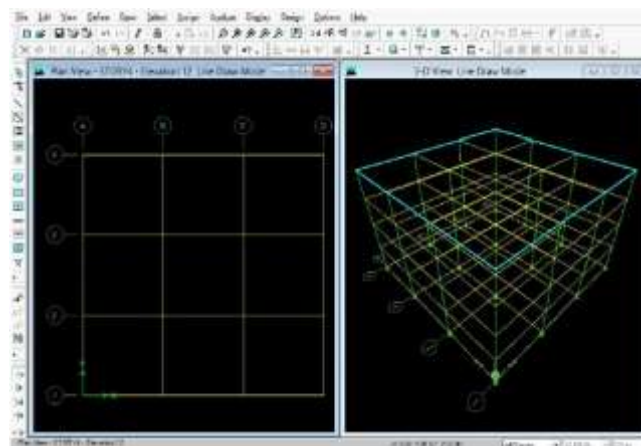
Fig.7 Beams after they are assigned

2.2 Drawing floor area:

Moreover we have to provide slabs, for which select define menu => wall sections after which a window will appears with choice modify/show section and add new, delete section. Now press button on add new slab and click on ok. A new display will appears which provides the section name as slab and the material is changed to the already defined one. The other data is kept as it is. We can change the display color to our convenience and then click ok.

To assign a slab, directly click on the draw rectangular areas and the other is to click on Draw menu=>Draw area objects=>draw rectangular areas. The properties of the object are changed to the defined slab and then assigned to the end points of the grid. The slab can be made visible by a click on Set Building view options on the top and the option object fill is marked in special effects options.
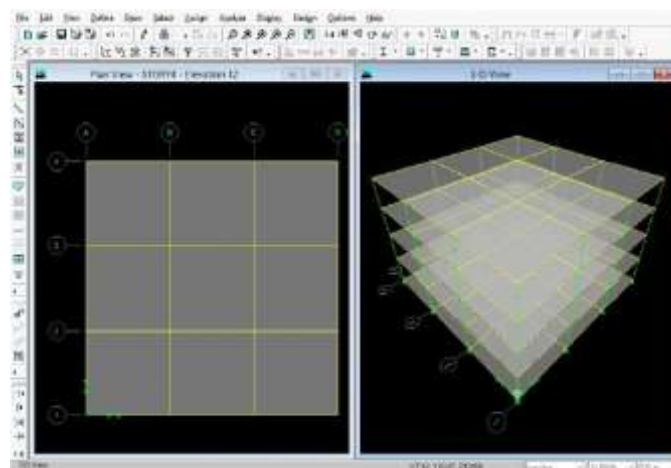

Fig.8 Building view options window
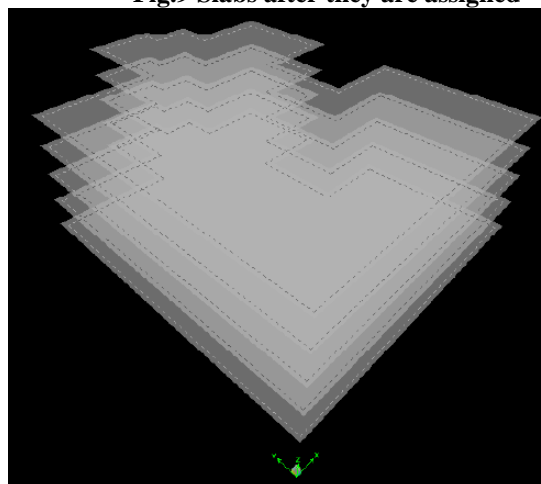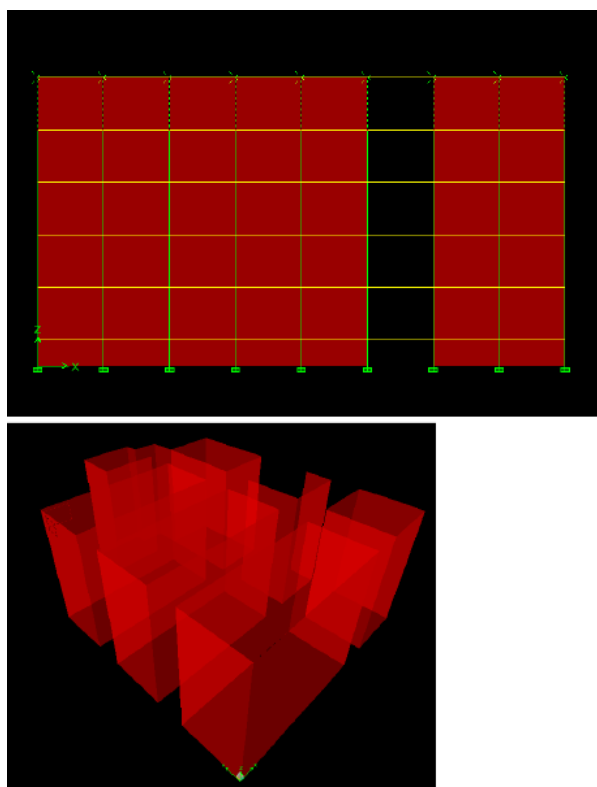

Fig.9 Slabs after they are assigned

Fig.10 Slab view of the civil block

After the slab is assigned to the structure the next step is to provide the wall for the structure which is the major portion of the construction as we are providing shear walls. Shear walls are directly provided as that of slab with the help of a special type of formwork using concrete. There is no character of bricks in this type of wall. There are some requirements for shear wall design i.e., the minimum thickness of the shear wall should be 150 millimeter or more.

Now for construction of a wall, firstly click define=>wall/slab/deck sections=>click to add new.

Wall=>name the wall and the material is selected as M30 and no more brick is used and then click ok without changing any other information.

To assign the wall, click directly on draw walls or create walls at click at the left side of screen or select draw=>draw area objects=>draw walls or create walls at click and allocate the walls at the required places. To make the wall visible, click on SetBuilding options and the object fill is.


Fig.11 Walls of the civil block

2. 3Assigning of loads:

After the columns, beams, walls and slabs are assigned now the loads are to be applied to the structure. In this software there are various load combinations used. Lateral loads and seismic loads play a vital role for shear walls.

To give any particular load, click Define=>Static load cases. Dead load and live load are already assigned in this display. For theallocation of any other loads change the name of the load in load option, select the load type in type option, and add the self-weight multiplier as required. The auto lateral load options gives different code books that are utilize across the world. We use IS 1893-2002 code. [4]
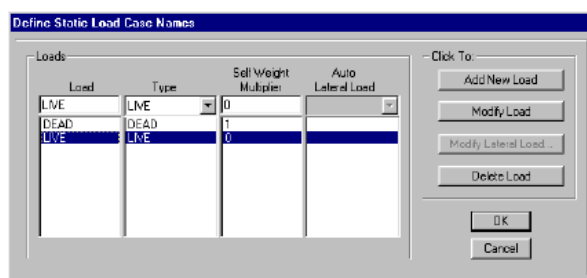
**Fig.12 Defining Static loads**

After defining loads that are required to be provided for the structure, now the loads are needed to be assigned. For the loads that are acting on beams, select all the beamsS and then click assign=>frame/line loads =>distributed=>select the load that is to be assigned and then click ok.
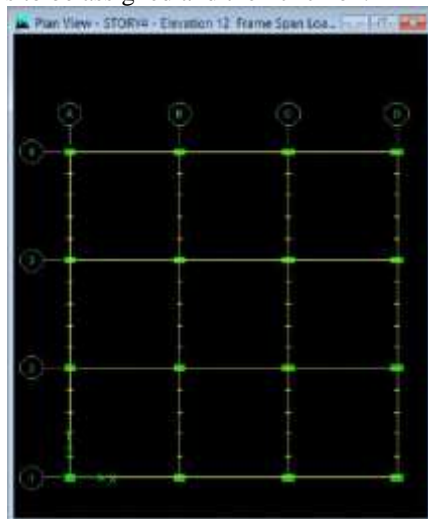

Fig.13 Frame/Line loads after they are assigned

For slabs and walls, select all the walls and slabs and then click on assign=>shell/area loads=>uniform. Select the load that is to be assigned and then click ok.

2. 4 Analysis: Before the application of loads the structure looks into the 3D view.
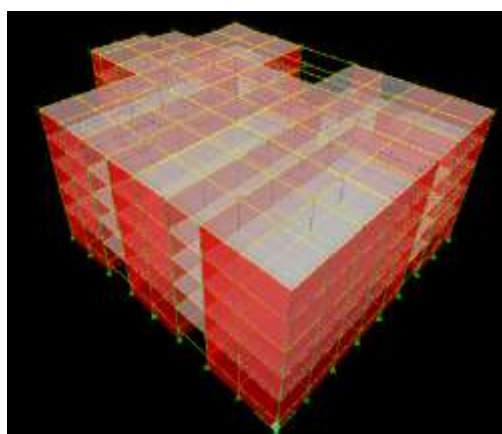
Fig.14 Civil block before analysis

After allocation of all the loads, click on analyze=>run analysis. When complete structure is analyzed then the deformed shape of the structure is shown in 3D view. This is due to the loads that are acting on all the sections i.e. beam, columns, walls and slabs.
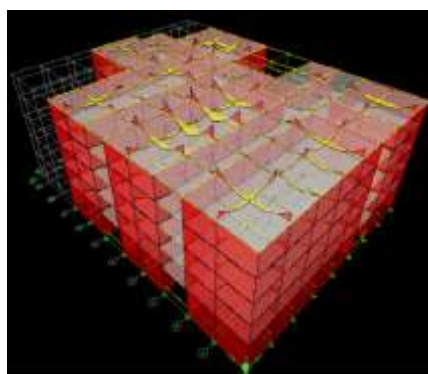
Fig.15 Civil block after analysis

III.   Conclusion

The input values in the E- Tabs software matched with the theoretical design. It is concluded that whenever an opening is expected the diameter of reinforcement is increased and horizontal ties aregiven inside the wall to replicate lintel beam in the wall for extra stability. Thereforein building shear walls are one of the most effective building elements which resist lateral forces during earthquake. Effect of lateral forces due to earthquake and high winds can be minimized by constructing shear walls damages. Shear wall has not only its strength, in order to accommodate huge number of population in a small area tall structured with shear walls are considered to be most useful.

Therefore for developing nation like India shear wall construction is considered to be a back bone for construction industry.

Acknowledgements

References

[1].   S.K. Duggal in his "Earth quake resistant design of structures" Page no:301, 8.12 about Shear walls.R.E. Moore, *Interval analysis* (Englewood Cliffs, NJ: Prentice-Hall, 1966).

[2].   S.K. Duggal in his " Earth quake resistant design of structures" 8.16 Design of Shear walls which is also given in Is code 13920:1993

[3].   U.H. Varyani in his second edition of (Structural Design of multi storey building)

[4].   IS 1893-2002 code

[5].   I.S 456:2000As per clause 32, design for wall describes, design of horizontal shear in clause 32.4 given details of how shear wall have to be constructed.

[6].   . I.S:1893 Criteria of Earth Quake resistant Buildings Part (3) page 23, clause 4.2 gives the estimation of earth quake loads.
In IS: 13920:1993 it gives the ductile detailing of shear wall as per clause 9, where
9.1 give general requirements.
9.2 shear strength
9.3 give flexural strength
9.6 give openings in shear walls.

[7].   Ductile detailing, as per the code IS: 13920:1993 is considered very important as the ductile detailing gives the amount of reinforcement required and the alignment of bars.

[8].   E-Tab Software User Manual.

[9].   Mallika.K, Nagesh Kumar "Analysis of Shear Wall in High Rise Unsymmetrical Building Using Etabs". G.Pulla Reddy Engineering College, Kurnool (A.P) India. November- 2016

[10].   IS: 875(part 1) -1987 Dead Loads on Buildings and Structures, New Delhi, India.

[11].   IS: 875(part 2) -1987 Live Loads on Buildings and Structures, New Delhi, India.

[12].   IS-1893(part 1):2002, Criteria for Earthquake Resistant Design of Structures

[13].   Ductile detailing, as per the code IS: 13920:1993 is considered very important as the ductile detailing gives the amount of reinforcement required and the alignment of bars.

[14].   In IS: 13920:1993 it gives the ductile detailing of shear wall as per clause 9