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CONSTRUCTION OF RESIDENTIAL BUILDING USING SHEAR WALL TECHNOLOGY

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ABSTRACT:
Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on them. However, when the buildings are tall, say, more than twelve storey's or so, beam and column sizes work out large and reinforcement at the beam-column junctions works out quite heavy, so that, there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in tall buildings. There will be no architectural difficulty in extending them thought the height of the building, care shall be taken to have symmetrical configuration of walls in plan so that torsional effect in plan could be avoided. Further, shear walls should get enough vertical load from floors, for which reason, nearby columns should be omitted and load taken to the shear walls by means of long span beams if required. Vibrations which are caused under the earth's surface generate waves which disturb the earth's surface, termed as earthquakes. It was said that earthquakes will not kill human but structures which are not constructed in considering the earthquake forces do. 60% of India lying in earthquake prone zone at which there is a need of increase of understanding the behaviour of earthquake, constructing and developing earthquake resistant structures. Shear walls to resist the lateral forces produced during earthquake. Shear walls behaviour depends upon the material used, wall thickness, wall length, wall positioning in building frame also. Shear wall is a concrete wall made to resist lateral forces acting on multi-storey buildings. It is provided, when the centre of gravity of building area & loads acted on it differs by more than 30%. in order to bring the centre of gravity in range of 30% concrete wall is provided i.e. lateral forces may not increase much.

INTRODUCTION

1.1 SHEAR WALLS

Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on them. However, when the buildings are tall, say, more than twelve storey's or so, beam and

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column sizes work out large and reinforcement at the beam-column junctions works out quite heavy, so that, there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in tall buildings. The shape and location of shear wall have significant effect on their structural behaviour under lateral loads. Lateral loads are distributed through the structure acting as a horizontal diaphragm, to the shear walls, parallel to the force of action. These shear wall resist horizontal forces because their high rigidity as deep beams, reacting to shear and flexure against overturning. A core eccentrically located with respect to the building shapes has to carry torsion as well as bending and direct shear. However torsion may also develop in building symmetrical featuring of shear wall arrangementswhen wind acts on the facades of direct surface textures (i.e. roughness) or when wind does not act through the centre of building's mass.

1.2 Structural Systems:

In the early structure at the beginning of the 20th century, structural members were assumed to carry primarily the gravity loads. Today, however by the advances in structural design/systems and high-strength materials, building weight is reduced, and slenderness is increased, which necessitates taking into consideration mainly the lateral loads such as wind ad earthquake. Understandably, especially for the tall building, as the slenderness, and so the flexibility increases, building suffer from the lateral loads resulting from the wind earthquake more and more. As a general rule, when other being equal, the taller building, the more necessary it is to identify the proper structural system for resisting the lateral loads. Currently, there are many structural systems that can be used for the lateral resistance of tall buildings.

1.2.1 Structural systems for tall buildings

i. Rigid frame systems
ii. Braced frame and shear-walled frame systems
iii. Braced frame systems
iv. Shear-walled frame systems
v. Outrigger systems
vi. Framed-tube systems
vii. Braced-tube systems
viii. Bundled-tube system

Structural systems of tall buildings can be divided into two broad categories: interior structures and exterior structures. This classification is based on the distribution of the components of the primary lateral load-resisting system over the building. A system is categorized as an interior structure when the major part of the lateral load resisting system is located within the interior of the building.

Advantages of shear wall

- They are very rigid in their own plane and hence are effective in limiting deflections.
- Properly designed and detailed buildings with shear wall have shown very good performance in past earthquake.
- Shear walls in high-seismic regions require special detailing. However, during earthquakes, even buildings

- with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse.
- Shear wall buildings are a popular choice in many earthquake-prone countries such as Chile, New Zealand and the U.S.
- Shear walls are easy to construct, becausereinforcement detailing of walls is relatively straight forward and therefore easily implemented at site.
- Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non-structural elements.
- Reinforced Concrete shear walls are the main components of high-rise building structures to resist lateral loads.
- Speed in erecting and dismantling forms
- Good appearance

2.0 LITERATURE REVIEW

2.1 Khan, F.R. and Sbrounis, J.A, **'Introduction of shear wall with frames in concrete Sabrcounis structure under lateral loads' (1964)**. Consider shear wall and frame as two separate entities and carried out analysis by iterative method to satisfy equilibrium and compatibility conditions at the points of connection wall and frame . Initially entire lateral load is assumed to be carried by the largest individual shear wall and the corresponding deflection at each floor are determined, next the remain shear wall are individually forced to the deflected shape of the first shear wall shear wall, negative shear wall is individual shear walls are computed these are the applied to first wall and so on. The accuracy of the results obtained by the method could be improved by specifying strict convergence criteria. The method can be applied to frame torsion, base torsion, plate rotation of the shear wall at any storey. They concluded that distribution of lateral shear between frame and shear wall depends not only on their lateral stiffness but also number of stories. Influence curves for distribution of storey shear between frame members and shear walls also presented.

2.2 Girija vallabhan - "Analysis of shear walls" (1969) found the finite element method to be more convenient than the finite difference method. The method consists the structural continuum to be analyzed into small finite elements interconnected at specific nodal points. This finite element posse the same properties as does the continuum. The assemblage of theses finite elements, subjected to boundary forces concentrated at the respective boundary nodal points, results in some displacement a all nodal points of the elements. In order to maintain compatibility of displacement on the boundaries of each element an arbitrary displacement function is assumed rectangular elements were found to be more accurate and are convenientfor application to shear wall problems then triangular elements from the assume displacement function, it is possible to derive a stiffness matrix related the nodal displacement and nodalforces of a finite element. By correctly super imposing the stiffness matrices of all the elements, the nodal displacements and nodal forces of the complete assemblage of elements can be related by the stiffness matrix equation. Finite element method was found to be suitable for analysis of shear wall problem.

2.3 Paulay.T, and Priestley , "Seismic design of reinforced concrete and masonry buildings" (1992). Presented most reinforced concrete buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls can large horizontal earthquake forces, the overturning effects on them are large. Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote.

Shear wall in high seismic regions require special detailing. However, in past earthquakes* even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, Like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non-structural elements (like glass windows and building contents).

2.4 JJ-Humar and s.yavari "design of concrete shear wall buildings for earthquake induced torsion" (2002) . He studied the damage after earthquakes has shown that torsional vibration of buildings, induced by lateral seismic ground motion, may cause serious distress in a structure, sometimes leading to its collapse. Most seismic codes include provisions for design against seismic torsion. The code provisions are specified in terms of design eccentricities that depend on the relative stiffness's of the lateral load-resisting elements. Also, the allocation of strength among the lateral load-resisting elements is related to the stiffness of such elements. The current practice is to determine the stiffness of an element from its given geometry. Recent studies have, however, shown that in reinforced concrete structures, the stiffness does not depend on geometry alone, but is strongly related to the strength of the element. Consequently, the conventional method of design of concrete structures for seismic torsion in which the stiffness of an element is considered as being independent of strength needs to be reviewed. In his study examines the relationship between strength and stiffness for concrete shear walls and the impact of such relationship on the provisions in the National Building Code of Canada for design against seismic torsion.

2.5 Tolga Aki , S "Lateral load analysis of shear wall frame structures" (2004). The purpose of this study is to model and analyze the non planar shear wall assemblies of shear wall-frame structures. Two three dimensional models, for open and closed section shear wall assemblies, are developed. These models are based on conventional wide column analogy, in which a planar shear wall is replaced by an idealized frame structure consisting of a column and rigid beams located at floor levels. The rigid diaphragm floor assumption, which is widely used in the analysis of multi-storey building structures, is also taken into consideration. The connections of the rigid beams are released against torsion inthe model proposed for open section shear walls. For modelling closed section shear walls, in addition to this the torsional stiffness of the wide columns are adjusted by using a series of equations. Several shear wall-frame systems having different shapes of non planar shear wall assemblies are analyzed by static lateral load, response spectrum and time history methods where the proposed methods are used. The results of these analyses are compared with the results obtained by using common shear wall modelling techniques.

3.0 METHODOLOGY SITE SELECTION

The seismic motion that reaches a structure on the surface of the earth is influenced by local soil conditions. The subsurface soil layers underlying the building foundation may amplify the response of the building to earthquake motions originating in the bedrock.

For soft soils the earthquake vibrations can be significantly amplified and hence the shaking of structures sited on soft soils can be much greater than for structures sited on hard soils. Hence appropriate soil investigation should be carried out to establish the allowable bearing capacity and nature of soil. The choice of site for a building from the failure prevention point of view is mainly concerned with the stability of the ground. The very loose sands or sensitive clays are liable to be destroyed by the earthquake so much as to lose their original structure and thereby undergo compaction. This would result in large unequal settlements and damage the building. If the loose cohesion less soils are saturated with water they are likely to lose their shear resistance altogether during ground shaking. This leads to liquefaction. Although such soils can be compacted, for small buildings the operation may be too costly and the sites having these soils are better avoided.For large building complexes, such as housing developments, new colonies etc. this factor should be thoroughly investigated and the site have to be selected appropriately. Therefore a site with sufficient bearing capacity and free from the above defects should be chosen and its drainage condition improved so that no water accumulates and saturates the ground especially close to the footing level.

3.2 Construction Procedure

- Excavation of soil for foundation
- Laying Plain Cement Concrete (PCC)
- Raft foundation
- Basement

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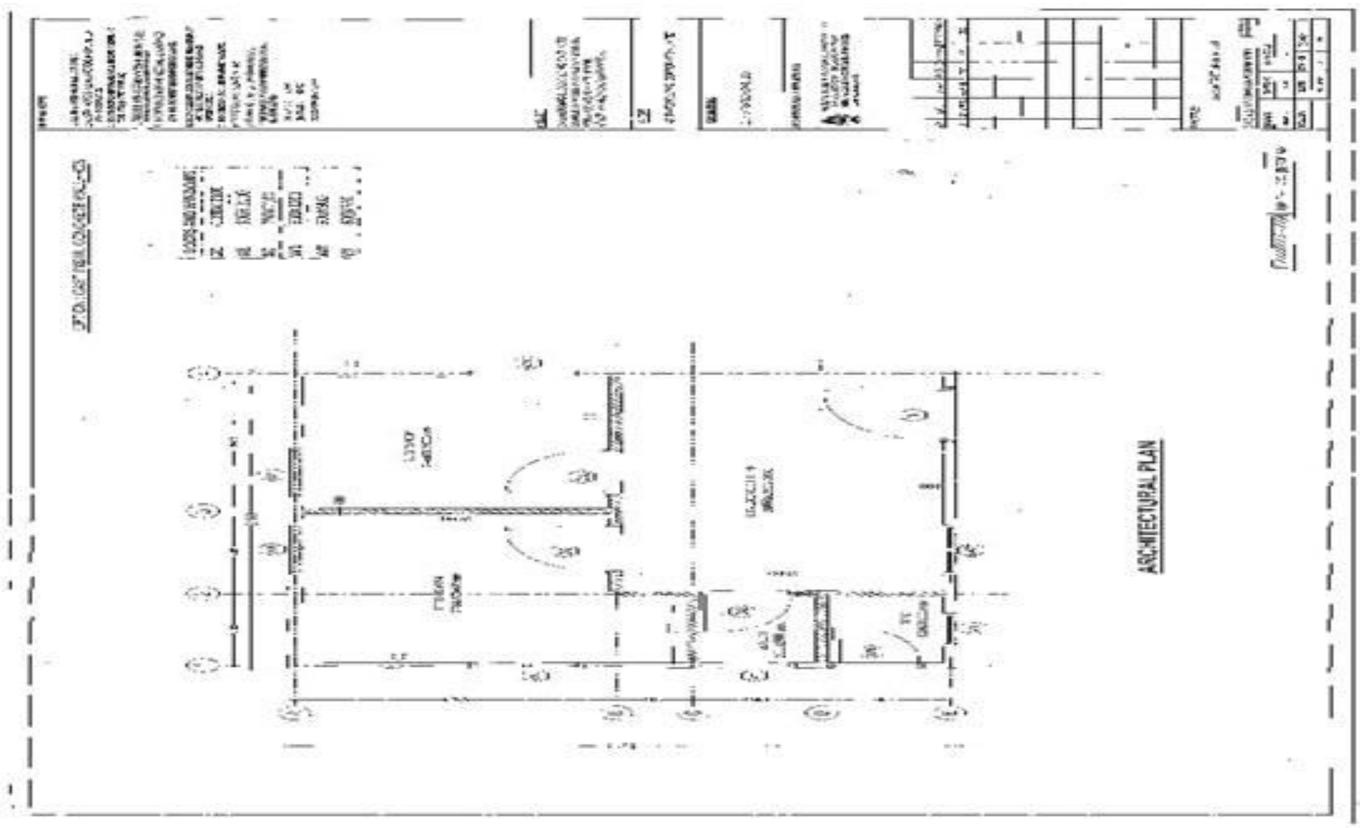
- Steel frame work
- Aluminum form work
- Self compact concrete
- Doors and Windows
- Finishings and white washing

3.3 Drawings

- Site drawings (plan, elevation, sections)
- Architectural drawings



4.0 DATA COLLECTION AND WORKING PROCEDURE

Building Specifications

Area: 62.71sq.m (75sq.yd)

Plinth area: 27.87 Sq. m (300sq.ft)

House size: (5.40 m*5.20m)

Storage space:4.64sq.m (50sq.ft) (2 Chajjas 2.74*0.487m, 1 loft 1.83*1.22m)

Facilities: 2 Bed rooms, Hall, Kitchen area, Bath room and Toilet.

Ceramic tiled flooring, Kitchen platform with sink. 3 no's water taps (Sink, Bath room, Western Commode)

Electrical points: 12 (5 Light point, 3 fan points, 4 Socket points)

Construction Technology:

Foundation: 150mm thick Shear wall (VRCC M25)

Walling and Roofing: 100 mm Shear Wall.

Foundation and footing:

PCC (1:3:6) – 100mm thick and 750mm width.

Raft foundation – VRCC M25 grade 200mm thick and 650 width.

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Basement:

VRCC M25 grade of 150mm thick and 1.3 m height.

Reinforcement: 8mm Diameter @ 300mm c/c vertically

@ 250 mm c/c Horizontally

Walling:

M25 grade Self Compacted Concrete (SCC) 100mm thick

Reinforcement: Wall 8mm Diameter @ 300 mm c/c Vertically250 mm c/c Horizontally upto roof level and for Roof 8mm Diameter

4.2 Materials required

- Cement
- Fine aggregate
- Coarse aggregate
- Steel
- Water proofing liquid

4.3 Equipments required

- JCB's
- Mechanical mixers
- Aluminum Shutters

Site clearing with Proclain

LAYING PLAIN CEMENT CONCRETE

4.5.1Materials and Tools used

- Auto level instrument – 1 Nos
- Wooden /Steel rammer – 1 Nos
- Mixer machine – 1 Nos

4.5.2 Scope of work

- Verifying levels and dimension
- Ramming the earth surface
- Placing the concrete.
- Ramming and finishing the concrete surface

P.C.C foundation of building

placing reinforcement for raft foundation

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Basement up to plinth level


Scoff holding & centering


Final view of building site

Activities	No. Of days
Site clearance	½
Excavation	½
Laying of PCC	½
Basement	½
Bar bending	1
Shuttering	4
Filling of SCC	1
Remove of shutters for walls	2
Remove of shutters for slab	4
Finishing & white	2

CONCLUSIONS:

The following conclusions are made from the present study:-

1. The following are the advantages by adopting shear wall technology
   a. Time of construction is low, it takes least time compared to normal construction even constructing tall building and also depending on the size of the building.
   b. Cost of construction is reduced up to 10% to 12%.
   c. Requirement of man power is less.
   d. Wastage of construction material is less.
   e. It gives high strength and high durability.
   f. Earthquake resistance capacity is high.
   g. Effective in lateral load distribution.
2. Shear wall technology is suitable at any place, mostly preferable in earthquake prone areas and quarry areas

3. Because of its heavy weight, the SBC of soil must be high.
4. The type of foundation i.e. either deep or shallow is depending on the SBC of soil (i.e. SBC of soil is 10tonne/sq.m)
5. By Providing steel in the form of skeleton to the building, resistance towords lateral forces and wind forces is in better manner
6. It gives good appearance, high strength and durability better than other technologies.

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