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DESIGN AND ANALYSIS OF MULTISTOREY (G+5) RESIDENTIAL BUILDING USING ETABS

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ABSTRACT
In present scenario buildings with shear wall is a typical feature in the modern multi-storey construction in urban India. Such features are highly undesirable in building built in seismically active areas. This study highlights the importance of explicitly recognizing the presence of the shear wall in the analysis of building. Design of RCC elements will also be perform as per IS-456 2000 for the building with shear wall .
A numerical study will perform using ETABS Software will be used for 3D multi storey (G+5)frames with and without shear wall to study the responses of the structure under different earthquake zones . Shear force , Bending moment, Axial force, inter storey drift, base shear, storey shear ,storey moment will be computed for both the buildings with and without shear wall and comparing the results

Keywords:
G+5 RCC building, ETABS software, structural analysis and design, wind load analysis, reinforced concrete construction, IS 456:2000, IS 1893, IS 875, lateral stability, displacement criteria, load combinations, finite element modelling, reinforcement detailing, beam column design, urban construction, structural optimization

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CHAPTER 1
INTRODUCTION

1.1 Design of RCC Structures

From a long time it has been the constant effort of structural engineers to improve their concepts of analysis and design so that an economical structure is obtained consistent with safety and serviceability. The introduction of various grades of steels helped in achieving considerable economy in the use of scarce minerals and in reducing the cost of construction.
These research developments have become truly international and this is particularly true in the field of “Limit state design of R.C.C.Structures.”The theory of elasticity itself is accurate and scientific the loads acting on a structure and the limiting stress of materials used in that structures cannot be accurately predicted. By specifying low values for working stress engineers thought they could ensure safety of structure.The working stress has failed to meet the challenges of constructing the voiding economically and at the same time ensuring safety and serviceability in a rational manner.After many researches the load carrying capacities of various structural members such as columns, beams etc. have been found in bending, shear, etc., individually and in various combinations. This lead to the assessment of ultimate loads the structures can carry bat failure.
The limit state design adopts characteristic values for strength of steel and concrete. The term characteristic strength means “values of the strength of material below which not more than 5% of the test results are expected to fall”. Further in structural design account taken out on the dead, live and wind load, creep, temperature etc. wherever possible. The term characteristic load means “values of which has a 95% probability of not being exceeded during the life time of the structure”.
The recommended values of partial safety factors for concrete are 1.5 and for steel is 1.15.

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Methods of design

1.Working stress method of design

It is earliest modified method of R.C.C structures. In this method structural element is so designed that the stress resulting from the action of services load as computed in linear elastic theory using modular ratio concept do not exceed a pre-designed allowable stress which is kept as some fraction of ultimate stress, to avail a margin of safety. Since this method does not utilize full strength of the material it results in heavy section, the economy aspect cannot be fully utilized in the method.

2.Ultimate strength method of design

This method is primarily based on strength concept. In this method the structural element is proportioned to with stand the ultimate load, which is obtained by enhancing the service load of some factor referred to as load factor for giving desired margin of safety.

3.Limit state method

When a structure or a part of a structure becomes unfit for use, it is said it have reached a limit state unfitness for use can arises in various ways and the aim of limit state design is to provide an acceptable probability that a structure will not reach any of the limit states during its service life. Limit states can be broadly classified into two main categories.

- Limit states of collapse which is concerned with the maximum load carrying capacity of the structure, namely the ultimate load state.
- Limit state of serviceability, which are concerned with cracking and deflection of the structure.

CHAPTER 2
THEORY AND METHODOLOGY

2.1 Introduction

Walls can be designed as plane concrete walls when there is only compression with no tension in the section. Otherwise, they should be design as reinforced concrete walls. Shear walls are specially designed structural walls incorporated in buildings to resist lateral forces that are produced in the plane of the wall due to wind, earthquake and other forces. The term “shear wall” is rather misleading as such walls behave more like flexural members. They are usually provided in tall buildings and have been found to be of immence use to avoid total collapse of buildings under seismic forces. It is always advisable to incorporate them in buildings built in regions likely to experience the earthquake of large intensity or high winds. Shear walls for wind are designed as simple concrete walls. The design of these walls for seismic forces requires special considerations as they should be safe under repeated loads. Shear walls are generally made of concrete or masonry. They are usually provided between columns, in stairwells, liftwells, toilets, utility shafts, etc. Tall buildings with flat slabs should invariably have shear walls.

2.2 Classification of shear walls

There are many types of reinforced concrete shear walls. Some of them are as follows:

1. Simple rectangular types and the flange walls. These are formed by columns and wall in between.
2. Coupled shear walls
3. Rigid frame shear walls
4. Framed walls with infilled frames

2.2.1 Simple rectangle and barbell type free standing walls

Barbell types of shear walls are formed when a wall is provided monolithically between two columns. The columns at two ends are then called the boundary elements.

These simple types were the first to be used in construction.Uniform distribution of steel along its length as is used in the simple shear wall is not as efficient as putting the minimum steel over the inner 0.7-0.8 length L of the wall and placing the remaining steel at the ends for a length 0.15-0.12L on either sides. These walls should be designed in such a way that they never fail in shear but only by yielding of steel in bending. Shear failure is brittle and sudden.

2.2.2 Coupled shear walls

If two structural walls are joined together by relatively short spandrel beams, the stiffness of the resultant wall increases: in addition, the structure can dissipate most of the energy by yielding the coupling beams

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with no structural damages to the man walls. It is easy to repair these coupling beams then the walls. These walls should satisfy the following two requirements

a. The system should develop hinges only in the coupling beams before shear failure.
b. The coupling beam should be designed to have good energy dissipation characteristics.

2.2.3 Rigid frames with shear walls

The interaction of simple shear wall and rigid frames of a tall building. The deflection of frame is in the shear mode, but the deflection of walls is in the bending mode. This interaction tends to reduce maximum moments but increase the maximum shears in the shear walls. This increase the tendency of shear failure in the shear walls and this factor should be allowed for design.

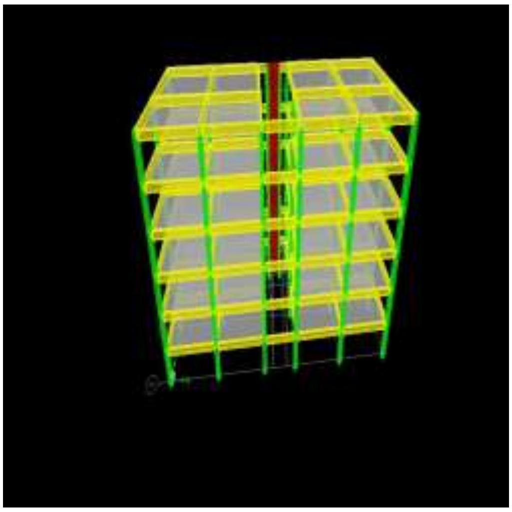
2.2.4 Framed walls, shear walls and infilled shear walls

Framed walls are cast monolithically, where as in filled frames are constructed by casting frames first and infilling it with masonry or concrete blocks later. A lot of literature is available on the mode of actions of these wall

CHAPTERS-3
ANALYSIS

3.1 **Basic Dimensions:** -Length - 41.52m. -No of stories: G+7.
-Breadth - 23.78m. -Storey height: Base floor ht- 4m
-Height – 25m. - Remaining floor ht- 3.5m

3D View :



3.3 STRUCTURAL PLANNING:

Structural planning is first stage in any structural design. It involves the determination of components and the method of analysis

As a success of any engineering project measure in terms of safety and economy, the emphasis today is being more on economy .structural planning is the first step toward successful structural design.

3.4 COLUMN POSITIONS

Positioning of columns

Followings are some of the guidelines principles for positioning of columns.

1. Column should be preferably located at or near the corner of the building and intersection of the walls, because the function of column is to support beams which are normally placed under walls to support them. The columns which are near to property line, can be exception from above considerations as the difficulties are encountered in providing footing for such columns.
2. When center to center distance between the intersection of walls is large or where there are no cross walls, the spacing between two columns is governed by limitations on span of supported beams because spacing of columns beside the span of the beams. As the span of the beam increase as the required depth increase and hence itself weight. On the other hand increase in total load is negligible in

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ease of columns due to increase in length. Therefore, columns are generally cheaper compared to beams on basis of unit cost. Therefore, large span of beam should be avoided for economy reasons.

3.5 POSITION OF BEAMS

Beams shall normally be provided under the walls and below every concentrated load to avoid these loads directly coming on slabs. Basic principle in deciding the layout of a component member is that heavy loads should be transferred to the foundation along the shorter path.

The maximum practical thickness for office/public buildings is 200mm, while minimum is 100mm.

3.6 SPANNING OF SLABS

Span of slab is decided by the position of supporting beams of walls. The designer is free to decide as to whether slab should be design as one Way or two way.

The points to be considered in making a decision i.e. whether the slab should be designed as one way or two way.

a) The slab act as two way slab when (Ly/Lx)<2.

b) A slab act as one way when (Ly/Lx)>2.

A two way slab is economical compared to one way slab, because steel along with directions act as main steel and transfer loads to all the supports, while in one way slab, main steel is provided along short span only and load is transferred toeither of two supports.

Two way is advantageous, essentially for large span(greater than 3m) and for live loads greater than 3kn/sq.m.

CHAPTER 4
DESIGN OF RCC ELEMENTS

4.1 DESIGN OF STRUCTURAL ELEMENTS:

4.1.1 DESIGN OF SLABS

INTRODUCTION:

A slab is a flat two dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfer the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges. The floor system of a structure can take many forms such as in situ solid slab, ribbed slab or pre-cast units. Slabs may be supported on monolithic concrete beam, steel beams, walls or directly over the columns.

4.1.2 DESIGN OF BEAMS

(a) INTRODUCTION

The beams and slabs in concrete structure are caused monolithic. Hence the structure becomes, a slab which is stiffened by concrete ribs in which the intermediate beams act as beam, and beams around the staircase, lift openings, support frames, etc act as I beams. The portion of slab that act as a-flange of T or L beams on its own thickness and span. Beams ma be singly reinforced or doubly reinforced. Beams are classified as SINGLY REINFORCED BEAM and DOUBLY REINFORCED BEAMS

d) DESIGN SPECIFICATION ACCORDING TO IS:456-2000 AND SP:16 EFFECTIVE DEPTHS

Effective depths of beams is the distance between the centroid of the area of the tension material not placed monolithically.

e) CONTROL OF DEFLECTIONS

The deflection including the effect of temperature, creep and shrinkage occurring after erection of partitions and the applications of finishes should not normally exceeds span I 350 or 20mm which ever is less.

f) SHEAR

A beam subjected to shear force and bending moment experienced diagonal tension.

Vertical shear force alone is not as critical when cpompared with the result due to the interjection of bending moment and shear force.

The resultant of these stresses produced diagonal tension, which may develop crack in the beam.

4.1.3 Design of Column:

(a) General

A column or struts is a compression member, which is used primarily to support axial compressive loads and with a height of at least lateral dimension.

Volume-09 Issue 06, June-2025

ISSN: 2456-9348
Impact Factor: 8.232

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(b) Effective length

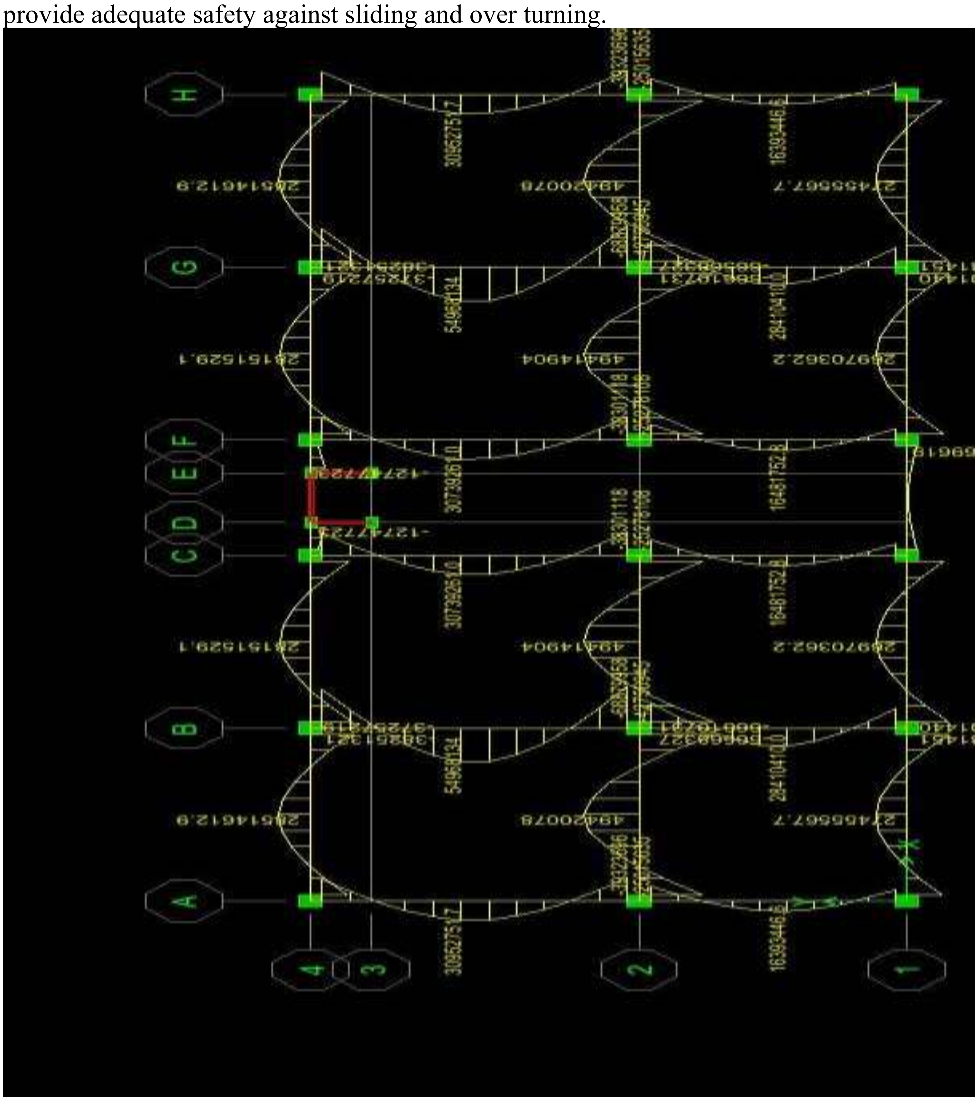
The effective length of a column is defined as the length between the points of contra flexure of the buckled column. The code has given certain values of the effective length for normal usage assuming idealized and condition shown in appendix D of IS 456(table 24)

A column may be classified as follows based on the type of loading

1. Axially loaded column.
2. A column subjected to axial load and uni-axially bending.
3. A column subjected axial load and bi-axial bending.

(f) Foundation

Foundation are structure elements that transfer loads the building or individual column to the earth if this loads are to be properly transmitted foundation must be designed to prevent excessive settlement and to provide adequate safety against sliding and over turning.



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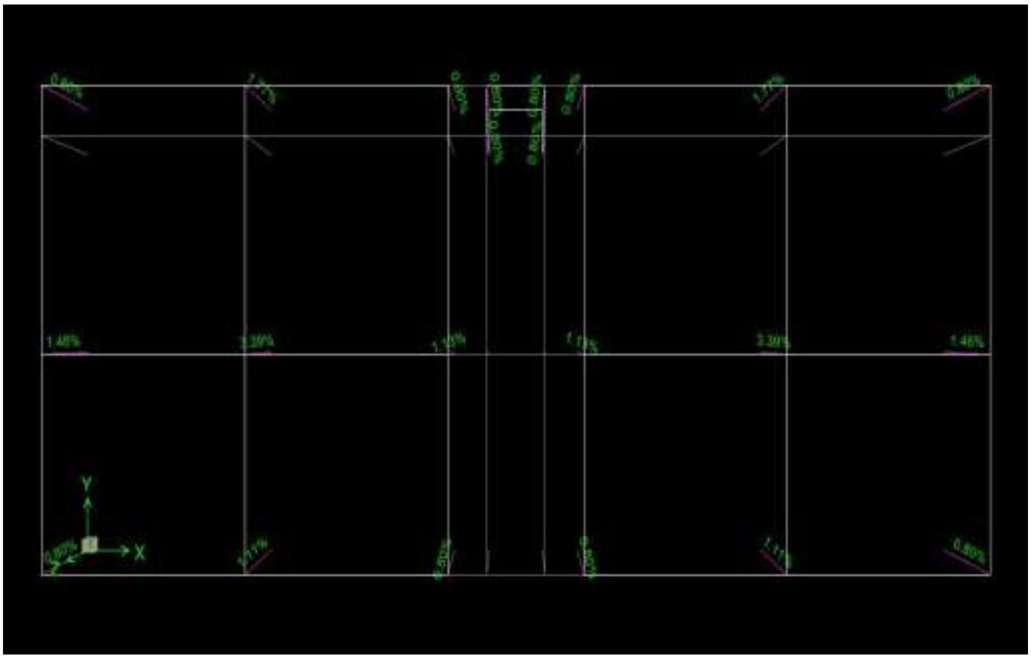

CHAPTER 5
CONCLUSION

The planning of a building is developed keeping in view, the Building Bye laws, Environmental conditions prevailing in that area. Height of a building is restricted as per the Municipal Authorities of the area. The drawings of plan is developed using AUTO CAD software.

The slabs are designed as per code of practice IS-456-2000 in accordance to LSM. The imposed loads are noted from code of practice Is-875-1987 (PART-II) the analysis of the frame as carried out in E-Tabs and the design of beams and columns are also carried out in E-Tabs, the footings, shear wall and stair case are designed manually as per code of practice.

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Codes:

1. IS 456 – 2000 Code of practice for Plain and Reinforced Concrete
2. SP-16 Design aid for Reinforced concrete to IS:456-1978
3. SP 34:1987 Hand book of concrete reinforcement and detailing
4. IS 1893-Part-1-2005 Criteria for Earthquake Resistant Structures
5. IS-875 (Part-1 to Part -5 for Dead, Live, Wind, Snow and Load Combinations.