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Design and Analysis of Multi-Storied Building by Most Economical Column Method

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Abstract: Hyderabad is the fifth largest city in our country. As it is rapidly developing in the field of construction in the city is very costly. The design process of structural planning and design requires Not only imaginations and conceptual thinking but also a sound full knowledge on how a structural engineer can economies the structure besides the knowledge of practical aspects, such as recent design codes, bye laws, experience, intuition and judgment. The main purpose of the project is to ensure and enhance the safety, keeping careful balance between economy and safety (i.e. most economical column method). The present project deals with the 3-D Analysis And Design of A Multi Storied Residential Building of (UNG-2 +G+10) By Using Most Economical Column Method .The dead load &live loads are applied and the design for beams, columns, footing is obtained ETABS with its new features surpassed its predecessors, and compotators with its data sharing.

Keywords: ETABS, Structural Analysis, STAADPro.

I. INTRODUCTION

Our main aim is to complete a Multi-storey building is to ensure that the structure is safe and economical against all possible loading conditions and to fulfill the function for which they have built. Safety requirements must be so that the structure is able to serve it purpose with the maintain cost. Detailed planning of the structure usually comes from several studies made by town planners, investors, users, architects and other engineers .On that, and a structural engineer has the main influence on the overall structural design and an architect is involved in aesthetic details. For the Design of the structure, the deadload, liveloads, seismic and wind load are considered.The analysis and design for the structure done by using a software package ETABS. In this project multi storied construction, we have adopted limit state method of analysis and design the structure. The design is in confirmation with IS456-2000.the analysis of Frame is worked out by using ETABS.

II. STATEMENT OF PROJECT

Salient Features: The design data shall be as follows.
1. Utility of Buildings: Residential Building
3. No of Storey :**(UNG-2 +G+10).**
4. Shape of the Building: Rectangular
5. No. Of Staircases: ONE
6. No. Of Lifts: One
7. Types of Walls: Brick Wall
8. Geometric Details
Ground Floor (G-2, G-1): 3.2 M
Floor-To-Floor Height: 3.0 M
Height of Plinth: 0.6 M above G.L
Depth of Foundation: 2 M below G.L
9. Material Details:
Concrete Grade: M30, M25 (COLUMNS AND BEAMS)
All Steel Grades: HYSDREINFORCEMENT of Grade Fe415
Bearing Capacity of Soil: 200 KN/M2
10. Type Of Construction: R.C.C FRAMED structure Method of analysis of statically in determinate portal frame.

- Method of Flexibility Coefficients.
- Slope Displacement Methods (Iterative Methods)
- Moment Distribution Method.
- Kani’s Method (Approximate Method).
- Cantilever Method.
- Portal Method.
- Matrix Method.
- STADD Pro
- ETABS.

A. Force methods

Originally developed by James Clerk Maxwell in 1864, later developed by Otto Mohr and Heinrich Muller-Breslau, the force method was one of the first methods available for analysis of statically indeterminate structures. As compatibility is the basis for this method, it is sometimes also called as compatibility method or the method of consistent displacements. In this method, equations are formed that satisfy the compatibility and force-displacement requirements for the given structure in order to determine the redundant forces. Once these forces are determined, the remaining reactive forces on the given structure are found out by satisfying the equilibrium requirements.

B. Displacement methods

The displacement method works the opposite way. In these methods, we first write load displacement relations for the members of the structure and then satisfy the equilibrium requirements for the same. In here, the unknowns in the equations are displacements. Unknown displacements are written in terms of the loads (i.e. forces) by using the load displacement relations and then these equations are solved to determine the displacements. As the displacements are determined, the loads are found out from the compatibility and load- displacement equations. Some classical techniques used to apply the displacement method are discussed.

C. Slope deflection method

This method was first devised by Heinrich Manderla and Otto Mohr to study the secondary stresses in trusses and was further developed by G. A. Maney extend its application to analyze indeterminate beams and framed structures. The basic assumption of this method is to consider the deformations caused only by bending moments. It's assumed that the effects of shear force or axial force deformations are negligible in indeterminate beams or frames. The fundamental slope-deflection equation expresses the moment at the end of a member as the superposition of the end moments caused due to the external loads on the member, while the ends being assumed as restrained, and the end moments caused by the displacements and actual end rotations. A structure comprises of several members, slope deflection equations are applied to each of the member. Using appropriate equations of equilibrium for the joints along with the slope-deflection equations of each member we can obtain a set of simultaneous equations with unknowns as the displacements. Once we get the values of these unknowns i.e. the displacements we can easily determine the end moments using the slope-deflection equations.

D. Moment distribution method

This method of analyzing beams and multi-storied frames using moment distribution was introduced by Prof. Hardy Cross in 1930, and is also sometimes referred to as Hardy Cross method. One goes on carrying on the cycle to reach to a desired degree of accuracy in an iterative method. To start with, this method, initially all the joints are temporarily restrained against rotation and fixed end moments for all the members are written down. Each joint is then released one by one in succession and the unbalanced moment is distributed to the ends of the members, meeting at the same joint, in the ratio of their distribution factors. These distributed moments are then carried over to the far ends of the joints. Again the joint is temporarily restrained before moving on to the next joint. Same set of operations are performed at each joints till all the joints are completed and the results obtained are up to desired accuracy. The method does not involve solving a number of simultaneous equations, which may get quite complicated while applying large structures, and is therefore preferred over the slope-deflection method.

E. Kani's method

This method was first developed by "Prof. Gasper Kani" of Germany in the year "1947". The method is named after him. This is an indirect extension of slope deflection method. This is an efficient method due to simplicity of moment distribution. The method offers an iterative scheme for applying slope deflection method of structural analysis. Whereas the moment distribution method reduces the number of linear simultaneous equations and such equations needed are equal to the number of translator displacements, the number of equations needed is zero in case of the Kani's method. This method may be considered as a further simplification of moment distribution method wherein the problems involving sway were attempted in a tabular form thrice (or double story frames) and two shear coefficients had to be determined which when inserted in end moments gave us the final end moments. All this effort can be cut short very considerably by using this method.

- Frame analysis is carried out by solving the slope−deflectionequations by successive approximations. Useful in case of side sway as well.
- Operation is simple, as it is carried out in a specific direction. If some error is committed, it will be eliminated in subsequent cycles if the restraining moments and distribution factors have been determined correctly

III. STRUCTURAL ANALYSIS

The procedure of structural analysis is simple in concept but complex. In detail. It involves the analysis of a proposed structure to show that its resistance or strength will meet or exceed a reasonable expectation. This expectation is usually expressed by a specified load or the demand and an acceptable margined of safety that constitutes a performance goal for a structure. The performance goals structural design is multifaceted. Foremost, a structure must perform its intended function safely over its useful life. The concept of useful life implies consideration of durability and established the basis for considering the cumulative exposure to time varying risks (i.e. corrosive environments, that performance is inextricably linked to cost, owners, builders, and designer must considers economic limit to the primary goal of safety and durability. In the view of the above discussion, structural designer may appear to have little control over the fundamental goals of structural design except to comply with or exceed the minimum limits established by law. While this is generally true, a designer can still do much to optimize the design through alternative means and methods that can for more efficient analysis techniques, creative design detailing, and the use of innovative construction materials and methods. In summary the goal of structural design are defined by law and reflect the collective interpretation of general public welfare by those involved in the development and local adoption of building could.

It is advantageous when kinematic indeterminacy< static indeterminacy. Alex Bendex first formulated this procedure in 1914 based on the applications of compatibility and equilibrium of compatibility and equilibrium conditions. This method derives its name from the facts that supports and displacements are explicitly computed. Set up simultaneous equation is formed from the solution of these parameters and the join moment in each or computed from these values. It is advantageous when kinematic indeterminacy<static indeterminacy. Alex Bendex first formulated this procedure

in 1914 based on the applications of compatibility and equilibrium of compatibility and equilibrium conditions. This method derives its name from the facts that supports and displacements are explicitly computed. Set up simultaneous equation is formed from the solution of these parameters and the join moment in each or computed from these values. This chapter reviews about some of the fundamental concepts of structural design and present them in a manner relevant to the design of light frame residential structures. The concepts from the basis for understanding the design procedures and overall design approach addressed in the remaining chapter of the guide. With this conceptual background, it is hoped that the designer will gain a greater appreciation for creative and efficient design of home, particularly the many assumptions that must be made.

The world is leading Structural Analysis and Design package for Structural Engineers.

- Starting the Program.
- Creating a New Structure.
- Creating Joints and Members.
- Switching On Node and Beam Labels.
- Specifying Member Properties.
- Specifying Material Constants.
- Specifying Member Offsets.
- Printing Member Information.
- Specifying Supports.
- Specifying Loads.
- Specifying the Analysis type.
- Specifying Post-Analysis Print Commands.
- Specifying Steel Design Parameters.
- Performing Analysis and Design.

IV. VIEWINGTHEOUTPUTFILE.

Verifying results on screen both graphically and numerically.

WORLD'S#2STRUCTURALANALYSISANDDESIGNSOFTWARESUPPORTINGINDIANANDMAJORINTERNATIONAL CODES.

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of geometrical nonlinear behaviors, making it the tool of choice for structural engineers in the building industry (Computers and structures Inc. 2003). The accuracy of analytical modeling of complex Wall Systems has always been of concern to the Structural Engineer. The computer models of these systems are usually idealized as line elements instead of continuum elements. Single walls are modeled as cantilevers and walls with openings are modeled as pier and spandrel systems. For simple systems, where lines of stiffness can be defined, these models can give a reasonable result. However, it has always been recognized that a continuum 2 model based upon the finite element method is more appropriate and desirable. Nevertheless this option has been impractical for the Structural Engineer to use in practice primarily because such models have traditionally been costly to create, but more importantly, they do not produce information that is directly useable by the Structural Engineer.

However, new developments in ETABS using object based modeling of simple and complex wall systems, in an integrated single interface environment, has made it very practical for Structural Engineers to use finite element models routinely in their practice (Ashraf Habibullah, 2002). Wall is a vertical load-bearing member whose length exceeds four times its thickness. Un-braced wall is designed to carry lateral loads (horizontal loads) in addition to vertical loads. Braced wall does not carry any lateral loads (horizontal loads). All horizontal loads are carried by principal structural bracings or lateral supports. Reinforced wall contains at least the minimum quantities for reinforcement. Plain walls contain either no reinforcement or less than the minimum quantity of reinforcement. The wall which is investigated in this research is consisting of several separated blocks which are placed in such a way that they form an infill wall for IBS construction. Recently the application of precast components in construction of many structures is accelerating due to its simplicity for fabrication and saving in time and labor force of many construction projects. IBS is a construction technique where components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site works (CIDB, 2003). 3 IBS is the new way forward in the construction industry. In 2012, the Malaysian government mandated that any governmental project should comprise of 70% IBS components (Kamarul Anuar Mohamad Kamar, Ir. Dr. Zuhairi Abd. Hamid, Mohd Khairolden Ghani and Ahmad Hazim Rahim, 2007). Precast frame which is made by combining beam and column is not new, but block work system research must be check to ensure the safety and reliability of the system before put into use for industrialize housing (Sharifah Faeza Binti Syed Abdul Rahim, 2012). Hence, many research centres and universities turned to contribute to this new born science field and consequently a thorough analyzing with ETABS is also necessary.

V. DESIGN OF MULTISTORIED RESIDENTIAL BUILDING

A. General

A structure can be defined as a body, which can resist the applied loads without appreciable deformations. Civil engineering structures are created to serve soma specific like, Human habitation, transportation, bridges, storage etc. in safe and economical way. A structure is assembling of individual elements like pinned elements (truss elements), beam elements, column, shear wall slab able or arch. Structural engineering is concerned with the planning, designing and the construction of structures. Structural analysis involves the determination of the forces and displacements of the structures or components of a structure that make up the structural system. The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

B. Foundation Design

Foundations are the structure elements that transfer loads from buildings or individual column to earth this loads are to be properly transmitted foundations must be designed to prevent excessive settlement are rotation to minimize differential settlements and to provide adequate safety isolated footings for the multistoried buildings. These may be square rectangle or circular in plan that the choice of types of foundation to be used in a given situation depends on a number of factors.

1. Bearing capacity of soil.
2. Types of structure.
3. Types of loads.
4. Permissible differential settlements.
5. Economy

C. Column Design

A coloumn may be defines as an element used primarily to support axial compressive loads and with a height of at least three times its lateral dimensions. The strength of column depends up on the strength of material, shape and size of cross section length and degree of proportional and dedicational restrains at the ends.

- Shape of cross section.
- Slenderness ratio (A=L+D)
- Type of loading, land.
- Pattern of lateral reinforcement.

The ration of effective coloumn length to least lateral dimension is released to as slenderness ratio.

D. Beam Design

A reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam. There are three types of reinforced concrete beams.

- Single reinforced beams.
- Double reinforced concrete.
- Flanged beams

E. Slab Design

A slab is a thin flexural member used in floor and roofs of structure to carry loads,, which are usually supported by wall or beams along its edges. Slabs are plate elements forming floor and roofs of buildings carrying distributed loads primarily by flexure.

F. One- Way Slab

One-way slabs are those in which the length is more than twice the breadth it can be simply supported beam or continuous beam.

G. Two-Way Slab

When the slab is supported on four edges and aspect ratio(Ly/Lx)<2 the slabs are designed as two way slabs. When slabs are supported to four sides two wayspanning action occurs. In two way slabs when loaded it bends in surface along both short and long span direction causing bending moments in both direction. Corners held down and bending moments coefficient obtained from table 26 of IS 456-2000. In slabs M25 grade concrete and Fe415 grade steel is used.

H. Loads for Residential Buildings

In general, the design loads recommended in this guide are based on:

1. Dead load.
2. Live load
3. Imposed loads.

1. Dead Loads: This is the permanent of the stationary load like self weight of the structural elements. This include the following

- Self-weight
- Weight of the finished structure part.
- Weight of partition walls etc.

Dead loads are based upon the unit weights of elements, which are established taking in account materials specified for construction, given IS 1911-1967. Dead loads consists of the permanent construction material loads compressing the roof, floor, wall, and foundation system, including claddings finishes and fixed equipment. Dead load is the total load of all of the components of the building that generally do not change over time, such as the steel columns, concrete floors, bricks, roofing material etc.

2. Live loads: These loads are not permanent or moving loads. The following loads includes in this type of loading: imposed loads(fixed) weight of the fixed seating in auditoriums, fixed machinery, partition walls these loads through fixed in positions cannot be relieved upon to act permanently throughout the life of the structure. Imposed loads (not fixed) these loads change either in magnitude or position very often such as the traffic loads, weight of the furniture etc. Live loads are produced by the use occupancy of the building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and constriction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform are loads, concentrated loads, and uniform line loads.

3. Imposed loads: Loads produced by intended use occupancy of a building including the weight movable portions distributed concentrated loads and loads that vibration and impact called imposed loads estimated by IS 456-2000.

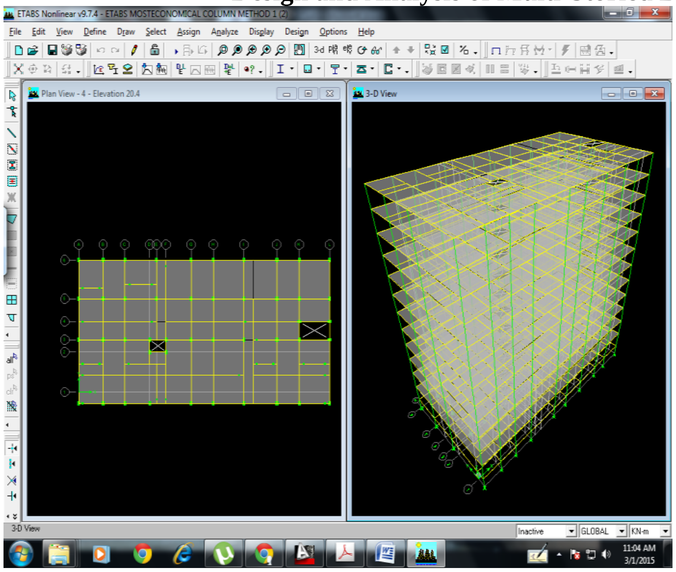

Fig1. 3-D Model.

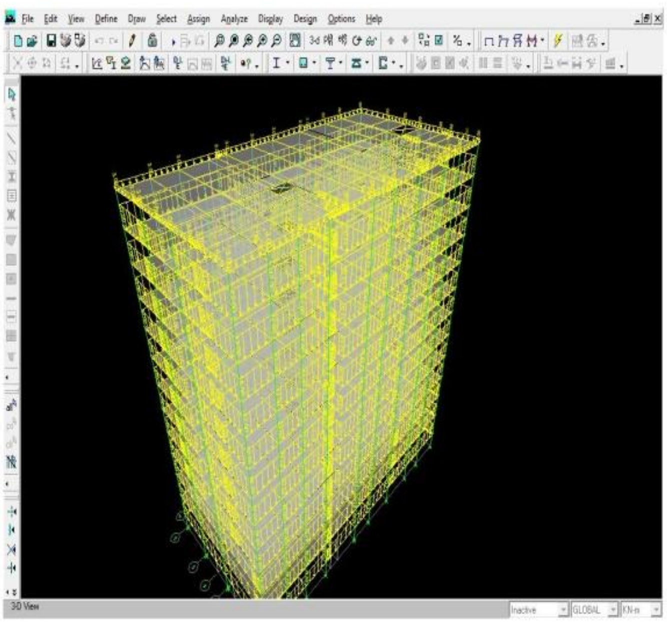

Fig2. Loads Assigned

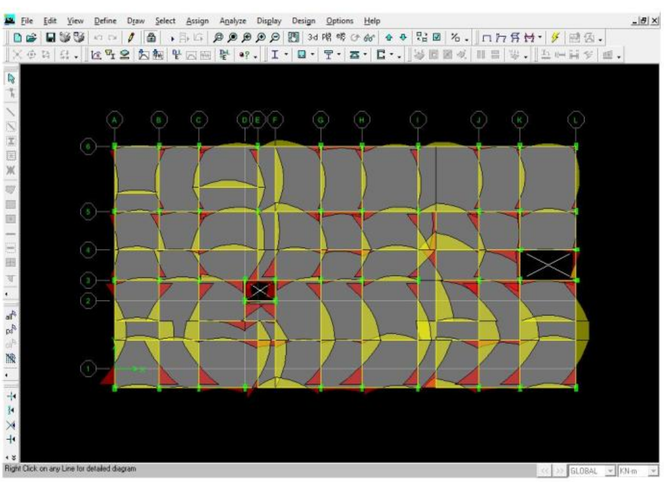

Fig3. B.M.D Bending Moment Diagram

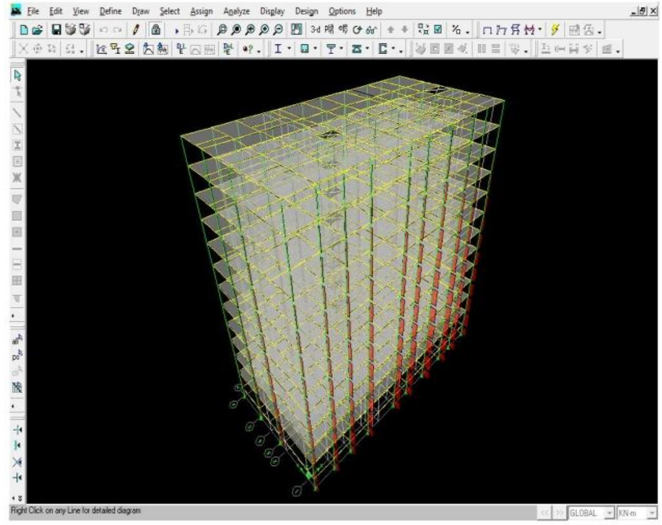

Fig4. Axial Force.

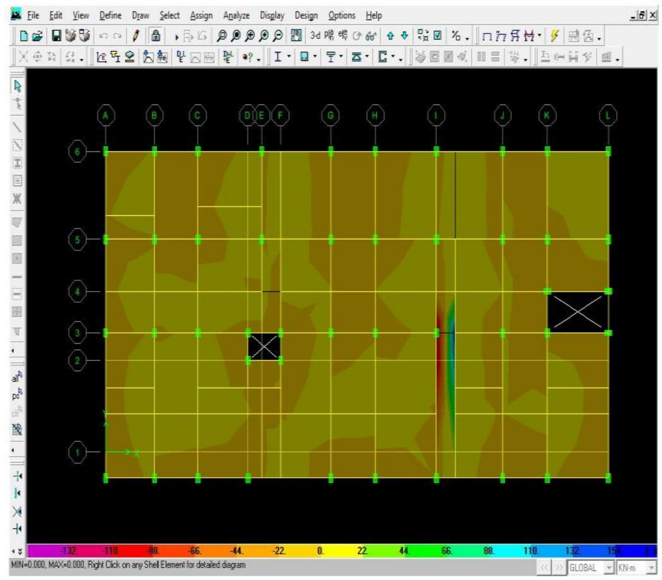

Fig5. Bending Profile of the Slab Along M11 Axis Design Output.

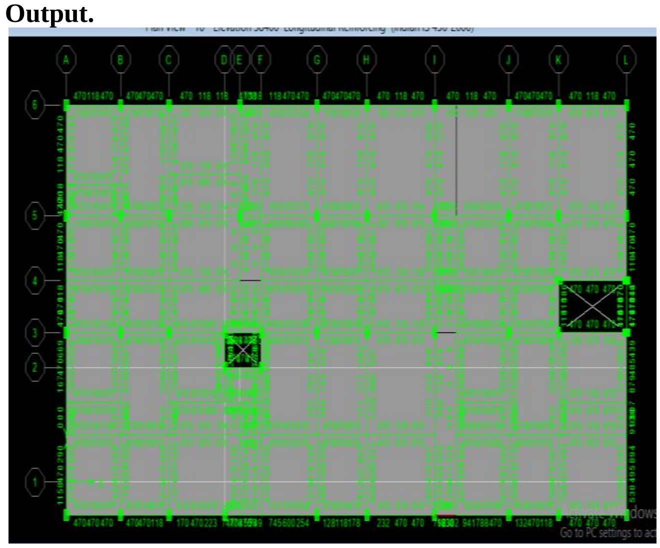

Fig6. Area of Steel in Beams .

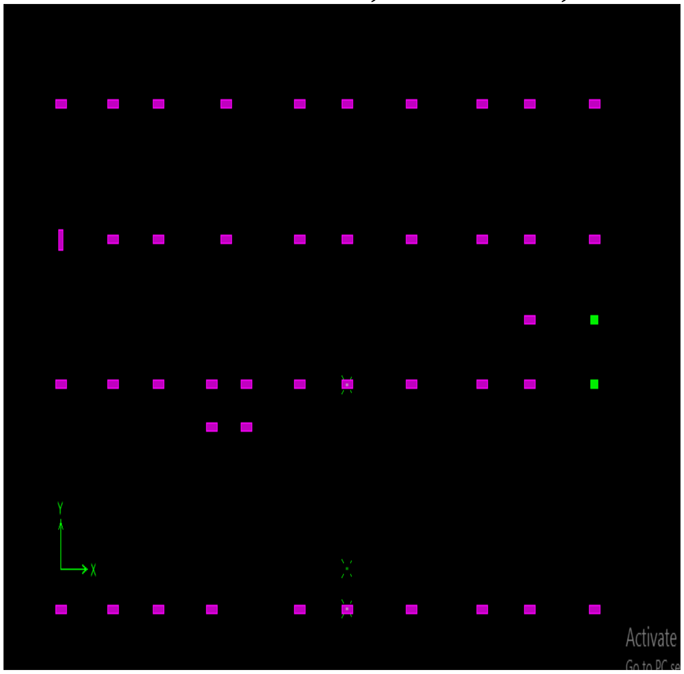

Fig7. Most economical column design when the column is been rotated along the shorter axis.

VI. CONCLUSION:

CASE -1 as our project deals with the most economical column method in this project we have design the structure in an economical way by reducing the sizes of the sections

by providing (750x750up to g-2, from (1st to 3rd -650x650, from (4^{th} to 6^{th} -300x450, from 7^{th} to till roof -300x380)

As the load is more at the bottom when compared to the top floors, there is no need of providing large sizes at the top.

CASE -2 Economizing the column by means of area of steel as per code, the min percentage of steel is 0.8%gross cross sectional area and max:6% as per code.

CASE-3 Economizing the column by means of column orientation is longer span longer direction will reduce the amount of bending as a result the area of steel is also reduced

CASE -4 (SCOPE FOR FUTHER STUDY) If the height of the structure is increased, the stiffness phenomenon (slenderness effect) i.e. long column effect will come in to the picture. As a result the amount of deflections are far greater than the codal provisions (is -456). Provision of bracing or provision of shear wall or tube system can be used as a new technique.

VII. REFERENCES

[1] IS 456

[2] ETABS user guide

[3] New IS: 456-2000 RC Designer..

[4] Multistoried buildings Analysis and Desing – Karvey and Shah, 2008

[5] Desing of Reinforced Concrete Structures – PROF. P.Seenivas sarma

[6] www.engineeringcivil.com

[7]www.google.com/Images.

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