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Comparative Study of G+8 Building with Flat Slab and Waffle Slab using Etabs

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ABSTRACT: The effects of column grid size, number of storeys, use of mild/high yield steel reinforcement, location of structural element, grade of concrete and provision of column heads in structural systems on the quantities of various constituents of reinforced concrete construction using flat slabs and waffle slabs have been studied and presented in the form of charts and mathematical equations. The charts give relationships between the quantities of each of the constituents of reinforced concrete construction, namely concrete, reinforcements and formwork, and each of the various parameters of the structure. **Flat slabs** are routinely being constructed only using the column, omitting the construction of beams, therefore affecting different aspects like the effectiveness, floor to floor height ratio, construction cost and freedom to the engineer whereas **Waffle slabs** are generally adopted in those structures having a smaller number of columns, a wider span of floors, requires more stability, are lightweight.

***KEYWORDS*:** yield, constituents, waffle slab, Flat slab, formwork, lightweight.

I. INTRODUCTION

Now days, there is an increase in housing requirement with increased population and urbanization. Therefore, building sector has gained increasing prominence. However, the fact that the suitable lands for building/construction- especially in the areas in which people live intensively- are limited and expensive shows that there is a necessity for optimal evaluation of these lands. Additionally, continuously increasing prices leads to increase in building costs; so, both dimensional and cost optimization becomes necessary and even indispensable.

When a building is projected, geometrical dimensions of elements belonging to carrier system of the structure are usually determined by using engineering capability and experiences gained over time. In sizing, the tensile forces to which the material to be subjected to should comply with the specifications. In the building design, the pre-sizing details provided are generally not changed much; sizes obtained in second or – at most third solution are taken as carrier system sizes. In fact, carrier system can be sized in infinite possibilities in a manner to ensure all the necessary conditions; and the cost of each carrier system alternative can be different from each other. The basic aim in the engineering is to find a design having lowest cost, and ensuring predicted limitations.

The multistorey building is becoming a necessary part of our living polished and tasteful from with increase in request for space The feeble amount of space is forcing us to lift the high level of structure as much as possible to give space to greatest point number of persons in general, and also in harmony with the to do with buildings design things necessary. The experience of design and building is to support the bits of material using long supports and hold the rays' using columns. These types of structures are called as beam- slab buildings. Two main groups according to the arrangement of slab, beams and girders, and columns are framed building and flat slab building. The flat slab structure are the structures in which slab is supported directly by column. In this, the floor-to-floor height reduces. As a result, the structure becomes cost effective

II. STAGES IN STRUCTURAL DESIGN

Every structure follows a specific path from its initiation to ultimate design as follows:

1. Structural planning of the building.
2. Model building in ETAB with assign material property and element

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3. Calculation of assign loads cases and load combination.
4. Structural analysis of the building both flat slab and waffle slab.
5. Design of the building as per analysis.
6. Drawing and detailing of the structural members.
7. Preparation of tables and graphs.
8. It is the responsibility of the structural engineer to construct the building structurally good, considering all the loads acting on the building. There are so many methods of conducting this design we use E-tab software.

III. AIM AND SCOPE OF WORK

The RC framed Buildings are considered for the analysis by assuming regular in plan. The asymmetric two different type of slab. The Flexibility of floor diaphragms are neglected and considered as rigid diaphragm. Analysis and design of multi-story building for flat floor system using etabs.the structure is analysed for both gravity and lateral loads (seismic and wind load). The individual structural elements are designed for worst load combinations.

1. Flat slab
2. Waffle slab

IV. OBJECTIVE

The main objective of this study is to identify various parameters that affected the ANALYSIS AND DESIGN OF MULTI-STORY BUILDING FOR FLAT FLOOR SYSTEM USING ETABS. The ETABS stands for extended 3D (Three-Dimensional) Analysis of Building Systems. The analysis and design is done to satisfy all the checks as per Indian standards.

- To study the effect of seismic level over the intensities of various parameter like displacement, base shear etc.
- Seismic analysis of flat slab structure by response spectrum method.
- A by comparison learning process between different types of flat bits of materials in terms of parameters like base get cut, storey drift, story drift.
- Analysis of G+8 buildings for zone factors and there comparative study for various parameters.
- The parametric studies comprise of base shear of structure. Maximum lateral displacement developed and generation of story drift, axial forces in the column.

V. DESIGN CONSIDERATION

- Methods of Design:

  Some of the popular design methods are:

  1 .Working Stress Method.

  2 . Ultimate Load Method.

  3. Limit State Method.

- Working Stress Method:

This is also known as MODULAR RATIO METHOD, F.O.S. METHOD and ELASTIC METHOD. In this method, analysis is based on the elastic theory assuming that both materials obey Hook's Law. It is a traditional method which. H is used for the design of reinforced concrete design where it is assumed that concrete and steel act together and are perfectly elastic at all stages and relationship between the loads and stresses is linear up to the collapse of the structure. It is based on the criteria that the actual stresses developed in the material under the action of the working loads is limited to a set of allowable values. Thus, the sections are designed in such a way that the stresses are within the permissible limits. This leads to un-economical sections, as the method doesn't utilize the full strength of the material resulting in heavier sections.

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Design Loads = working /service loads.

Design Stresses = characteristic values /F.O.S

F.O.S For concrete = 3 ---- for bending

4 ---- for shear / compression

F.O.S for Steel = 1.78 ---- for bending, shear & compression.

DEFECTS:

It neither shows its real strength nor gives true factor of safety of structure against failure.

It results in larger % of compressive steels then limit state design.

- Ultimate Load Method:

This is also known as LOAD FACTOR METHOD.

In this method, inelastic behavior of concrete is taken into account. At the failure the material tends to behave elastically, the strain increases many times beyond those in the elastic theory and stress distribution adjusts itself to enable member to develop maximum capacity. In this method, service loads are proportioning the section to carry up to the ultimate strength of the material.

Design Load = Working load * load factor

Design Stress = characteristic value / Load factor.

Load Factor = 1.5 ----- Concrete

= 1.15 ----- Steel.

DEFECTS:

This method gives slender sections but larger deflections and larger cracks. Thus, in this method serviceability is not taken care off.

- Limit State Design:

It is an ideal method of design which takes into consideration not only ultimate strength but also serviceability and durability requirement. It includes merits of both elastic and ultimate theories. When a structure or apart of the structure becomes unfit for It is said to have reached its “LIMIT STATE”. This method is to provide an acceptable probability that the structure will not reach any limit state during its services life time.

Design loads = working loads * P.S.F.

Design stress = characteristic values/ P.S.F.

P.S.F. depends on the load combinations as per cl. 36.4.1, IS-456-2000.

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It consists of:

1. Limit state of collapse.
2. Limit state of serviceability.
3. Limit state of collapse:

It is the limit state on attainment of which the structure is likely to collapse. It relates to strength and stability of the structures. Design to this limit ensures safety of structure against collapse

A. Limit state of collapse includes:

1. Bending
2. Shear
3. Compression
4. Torsion

B. Limit state of serviceability:

It relates to performance and behavior of structure at working loads and is based on causes affecting serviceability of the structure. It concerns with cracking and deflection of the structure.

C. Limit state of serviceability includes:

a. Deflections
b. Vibrations
c. Cracking
d. Durability

VI. PROBLEM STATEMENT

In this project we will study G+8 storey RCC building of 12m x 12m panel. The construction Technology is R.C moment resisting frame and Grid slabs. The modelling is done in ETABS. The structure is divided into frame and shell elements. Grid lines are made for the x, y and z coordinates and the wall is drawn from scratch. Boundary conditions are assigned to the nodes wherever it is required. Boundary conditions are assigned at the bottom of the wall i.e., at ground level where restraints should be against all movements to imitate the behaviour of structure. The material properties are defined such as mass, weight, modulus of elasticity, Poisson's ratio, strength characteristics etc.

Table 2. General Data for Design

Building Description	
Plan Dimension	12 x 12 M
Length in X-direction	12 M
Length in Y- Direction	12 M
Floor to Floor Height	3 M
No. Of stories height	G+8
Total Height of the building	27 M
Thickness of Slab	200 MM

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Beam	2 3 0 × 3 8 0 MM
Size of Column	2 3 0 × 4 5 0 MM
Grade of Concrete	M-25
Grade of Steel	FE 250
Panel Dimension	4 m × 4 m

Table 2. General Data for Material Specification

MATERIAL SPECIFICATIONS	
Grade of Concrete, M40	fck= 40N/mm2
Grade of Steel	fy= 415N/mm2
Density of Concrete	ϒc= 25kN/m3

VII. LOAD CASES AND LOAD COMBINATION

a. LOAD CASES

1. Dead Load
2. Live Load
3. Earthquake Load On X-Direction
4. Earthquake Load On Y-Direction
5. Wind Load On X-Direction
6. Wind Load On Y-Direction

b. LOAD COMBINATION

1. 1.5(DL+LL)
2. 1.2(DL+LL+WX)
3. 1.2(DL+LL+WY)
4. 1.2(DL+LL+EQX)
5. 1.2(DL+LL+EQY)
6. 0.9(DL+LL+WX)
7. 0.9(DL+LL+WY)
8. 0.9(DL+LL+EQX)
9. 0.9(DL+LL+EQY)

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VIII. TYPICAL LAYOUT OF PROBLEM STATEMENT

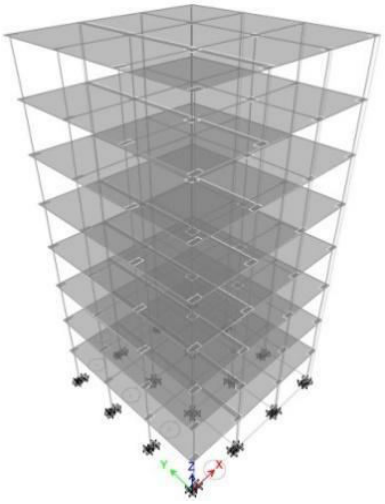

Fig. Plan View of Flat Slab Building.

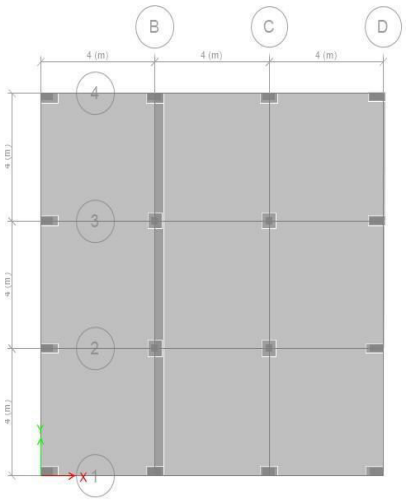

Fig.3 D View of Flat Slab Building

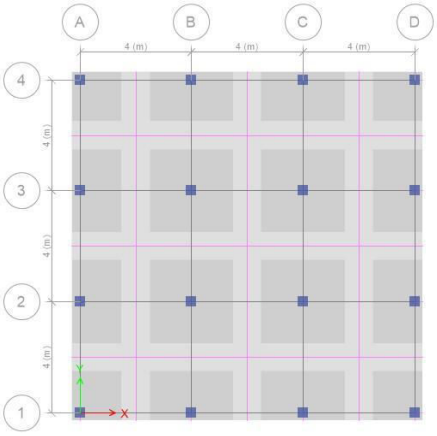

Fig.3 Plan View of Waffle Slab Building.

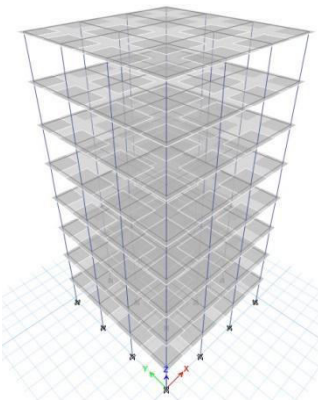

Fig 4.3D View of Waffle Slab Building

IX. RESULT

1. MAXIMUM STORY DRIFT

Table.3 Maximum Story Drift

SLAB TYPE	STORY	STORY DRIFT
FLAT SLAB	STORY 8	0.000257
WAFFLE SLAB	STORY 8	0.00002

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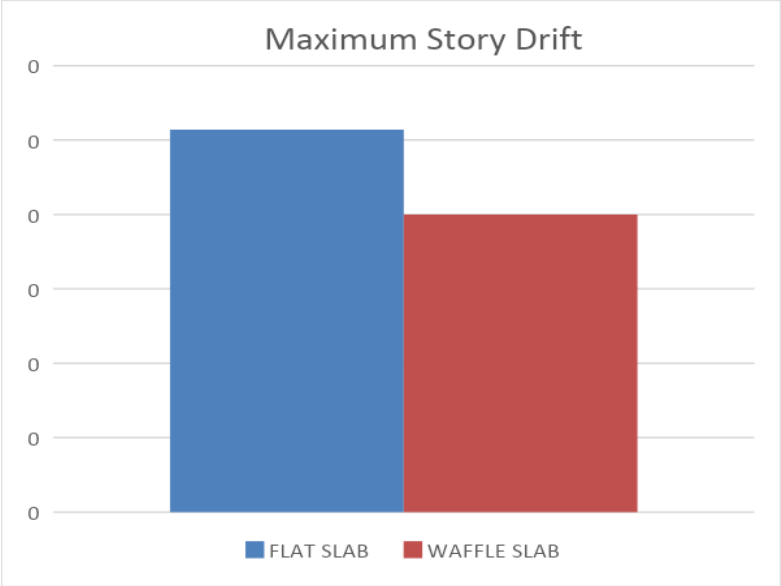

CHART 1. MAXIMUM STORY DRIFT

2. MAXIMUM STORY DISPLACEMENT

Table 4. Maximum Story Displacement

SLAB TYPE	STORY	STORY DISPLACEMENT (MM)
FLAT SLAB	Story 8	0.00297
WAFFLE SLAB	Story 8	0.0390

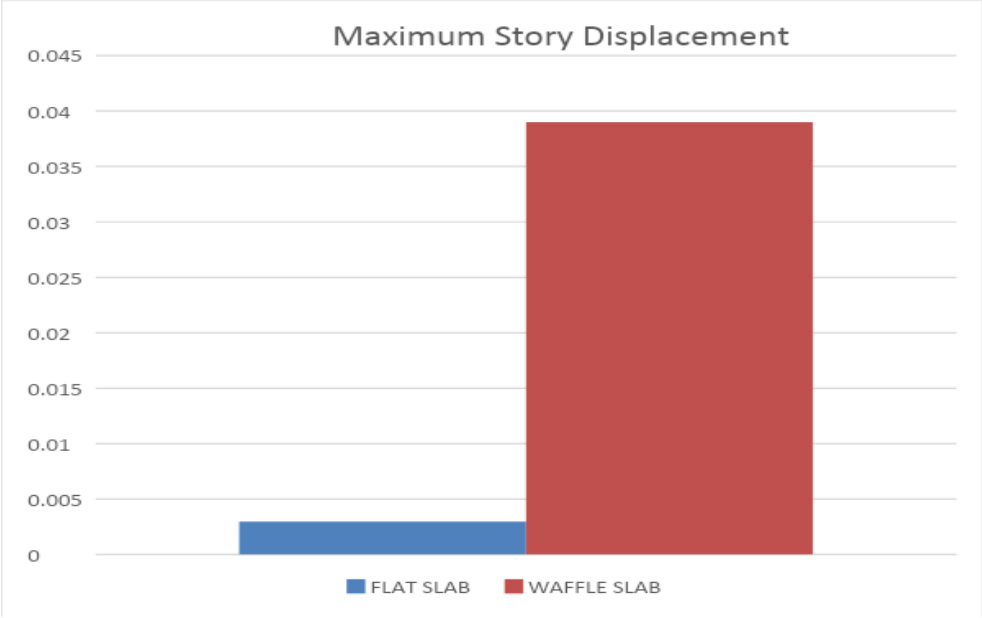

CHART 2. MAXIMUM STORY DISPLACEMENT

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3. STORY OVERTURNING MOMENT

Table . Story Overturning Moment

SLAB TYPE	STORY	MAX. OVERTURNING (KN/M)	MIN. OVERTURNING (KN/M)
FLAT SLAB	BASE	2.152	-7.89
WAFFLE SLAB	BASE	-1.66	-5.5

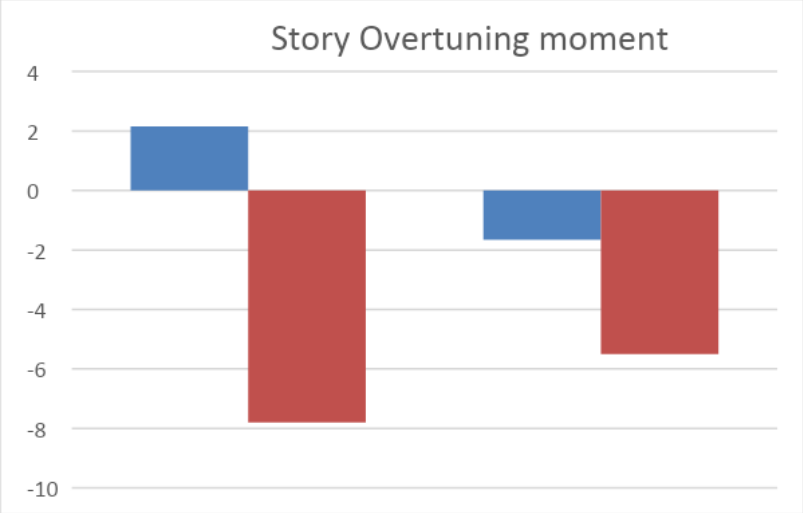

CHART 3. STORY OVERTURNING MOMENT

X. CONCLUSION

1. Waffle-slab building structures possesses major advantages over traditional slab-beam-column structures because of the free design of space, shorter construction time, architectural –functional and economical aspects.
2. Flat slab has high story displacement, troy drift and story overturning moment as compared to waffle slab
3. Because of the absence of deep beams and shear walls, flat-slab structural system is significantly more flexible for lateral loads then traditional RC frame system and that make the system more vulnerable under seismic events.
4. The purely flat-slab RC structural system is considerably more flexible for horizontal loads than the traditional RC frame structures which contributes to the increase of its vulnerability to seismic effects.
5. The critical moment in design of these systems is the slab-column connection, i.e., the penetration force in the slab at the connection, which should retain its bearing capacity even at maximal displacements. The ductility of these structural systems is generally limited by the deformability capacity of the column-slab connection.
6. To increase the bearing capacity of the flat-slab structure under horizontal loads, particularly when speaking about seismically prone areas and limitation of deformations, modifications of the system by adding structural elements are necessary.

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