Economical Studies on Frame, Flat And Grid Structures of G+10 Multi Storied Building

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Abstract- *In the design of multi storey structures, large column free area are preferred for maximum service utility. Optimum spacing of columns and geometric configuration of structural elements is a prime consideration for strength and performance of the structure. As per the existing Indian building codes, few guidelines are available for geometric configuration of the structural elements in a multi storied buildings. In most occasions, building architects influence the configuration of structural elements (such location of columns, slab system etc) rather than the decision by structural engineer. This practice makes serious concern about the economy of the structure. There is a need for engineering judgment to develop efficient structural system based on cost of structure. This paper provides basic guide lines to the structural engineer to impart his decisions about economic location of columns and the configuration of all structural elements in the design of multi storied structures .This study focused on economic criteria of Reinforced Concrete multistoried buildings (G+10) constructed over a rectangular plot area of different kinds of slab systems including nominal slab, flat slab and grid slab. Slabs are analyzed by STAAD.Pro software, flat slabs and grid slabs are analyzed manually.*

I. INTRODUCTION

Traditionally the spacing of column and it's geometric configurations are not paid much Importance in the design of high raised buildings. Long span columns are generally preferred for serviceability but the columns are subjected to high shear and moments. In view of reliable economy of the structure, there is a need for limitation on span, size and spacing between columns. Structural configuration is a key aspect for economy of building, which mostly relayed on location of columns and their configurations. Position of columns shows significant influence on load transfer mechanism, integrity of the structure and failure criteria. Long span structures are generally associated with high self weight, greater depth of beam and long anchorage system at beam column joints. The progressive collapse of structure was mainly influenced by geometric configuration of columns and the other structural elements such as beams, slab and joints. In this context limited guidelines are available in the present building codes for column configuration and economic structural system.

1.1.OBJECTIVE

In the design of multi storey structures, large column free areas are preferred for maximum service utility. Optimum spacing of column and geometric configuration of structural elements is a prime consideration for strength and performance of structure. As per the existing Indian building codes, few guidelines are available for geometric configuration of the structural elements in a multi storied buildings. In most occasions, building architects influence the configuration of structural elements (such location of columns, slab system etc) rather than the decision by structural engineer. This practice makes serious concern about stability, strength and economy of the structure. There is need for engineering judgment to develop efficient structural system.

1.2. DESIGNS CONSIDERATION:

1.2.1 Geometry:

Rectangular axis symmetric geometry of ten storied RC framed structure considered for design model.The structure is a RC moment resistant frame,and the developed models are, with and without internal columns, and of different slab system such as RC flexural slab,RC grid floor and Pretension slab (PT). Duing the design phase, the size of the structure considered as 18.3 m x 36.6 m **1.2.2.Design loads**: The design loads are considered as per IS 456-2000, IS875-1987(part I,II and III) and IS 1893-2000for gravity and lateral loads. The wind speed considered as 50m/s, terrain category II with the type of structure class B. The Structure located in sesimic zone II with zone factor 0.16.Limit state method used in the design of RC structure.

1.2.3.Soil and foundation:

The foundation located on medium coarse grained soil with allowable bearing pressure 400 kN/m^2. The ground water located below the foundation. RC Stepped footing used in sub structure.

1.2.4.Materials:

M_{20} grade concrete, Fe415 grade HYSD steel used in the design of RC elements. The RC design mix confirmed to IS: 1019- 1974 using OPC 53grade cement, medium coarse grained soil and 20mm down coarse aggregate.

1.3.STRUCTURAL CONSIDERATIONS

1.3.1. General:

The aim of the structural design of long span floors is to provide a service utility and economical floor structure. A serviceable long span floor is one has sufficient strength to carry the permanent and imposed loads as well as adequate stiffness to control deflection limits and vibrations.

1.3.2.Strength:

In essence many are follows limit-state design procedures and principles and require those actions for each limit state is determines the structure and it's components are analyzed for the appropriate actions by using the specified combinations of factored loads. The structural responses under the above actions should not exceed the appropriate member or section capacity.

1.3.3.Deflection:

Designer should appreciate the deflection is important and it reflects to the strength in the structural design of concrete floors, particularly in the design of shallow reinforced concrete floors systems. IS 456 suggests a limit of span/250 for the total deflection.

For two-way floor systems that are flat plates or flat slabs deflection of the column strip may necessary to be limited to 25–30 mm. So that the deflection in centre of the slab between columns in the middle strip is not too high

II. LITERATURE REVIEWS

Pawan Pandey & Dilip Kumar (2014) studied in Seismic load Effect on Building Configuration, that the behaviour of building during Earthquake depends critically on its overall shape, size and geometry. The Seismic performance of building is available and new design methods should account for the building ability to dissipate energy and the effect of the lateral deformation. These aspects involve both plan and structural configuration of building.

R.K.Makode (2014) discussed about flat slab buildings in which slab is directly resting on columns, have been adopted in many buildings constructed recently due to advantage of reduction in floor to floor heights to meet economical and architectural demands.

Rahman1 (2013) studies on design of R.C.C. as well as pre-stressed concrete flat slabs for different spans and then compare those results.

III. STRUCTURAL PLANNING

3.1 Introduction

After getting an architectural planning of the building, the structural planning of building framing is done. Structural planning is first stage in every structural design. It involves the determination of suitable form of structure, material used, and the structural system, the layout of its geometric components and the method of analysis. As the success of an engineering project is measured in terms of safety and economy, the emphasis today more on economic cost. Structural planning is the first level towards successful structural design.

3.2 Building bye laws & Regulations

Every locality contains its own peculiarities with respect of whether conditions, availability of materials and labor. Thus it adopts own methodologies of contractions. Every locality prepare certain rules and regulations cover in the requirements of buildings, ensuring safety of the public through open areas, minimum size of rooms, and height and area known as building bye-laws. Byelaws give the provision for following things.

- Line of building frontage and minimum lot sizes.
- Open spaces around residential building.
- Minimum standard dimensions of building elements.
- Provisions for lighting and ventilation.
- Provisions for safety from explosion.
- Provisions for means of access.
- Provisions for drainage and sanitation.
- Provisions for safety of works against hazards.
- Requirements for off-street parking spaces.
- Requirements for landscaping.
- Special requirements for low income housing

3.3 Positioning and Orientation of column

Columns should preferably be located at near the corner of building and at intersection of beam. The base of column is to support slabs or beams. Larger spacing of columns not only increases the span and the cost of the beam but it increases the load on the column at each floor posing problem of stocky columns in lower story's of a multi-storied building.

Orient the column so that the depth of column is contained in the major plane of bending (or) is perpendicular to the major is of building. So as to gets larger moment of inertial and greater moment resisting capacity. Projection of columns outside the wall in the room should be avoided as they not only give bad appearance but also obstruct the use of the floor space and create problems in placing furniture.

3.4 Positioning of beams:

i. Since beams are primarily to support slabs, its spacing shall be decided by the maximum span of slabs.
ii. Slab requires the maximum volume of concrete to carry a given load. Therefore the thickness of slab is required to be kept minimum.
iii. Since in our project the design is of flat slabs the beams are provided only on the periphery of the building slab.

3.5 Selection of slabs:

Slabs are plate elements forming floor and roofs of building and carrying loads primarily by flexure. Inclined slabs may be used as ramps for multi-storey car parks. A staircase can be considered be an inclined slab. A slab may be supported by beams or walls and may used as the flanges of a T, L-beam. Moreover, a slab may be simply supported or continuous over one more supports and is classified according to the manner of support:

a) One way and two way slabs
b) Flat slabs resting directly on columns with no beams and
c) Grid floor with ribbed slabs

3.6 Selection Of Footing:

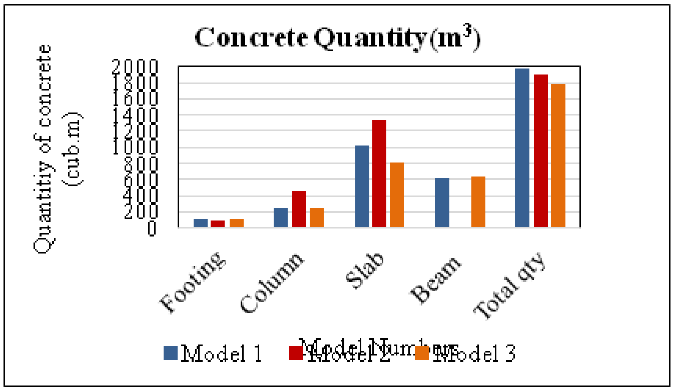
A building is generally composed of super structure above the ground and a substructure which forms the foundation below ground. The safe bearing capacity of soli must not be exceed otherwise excessive settlement may occur, resulting in damage to the building and it service facilities, such as water or gas mains. Foundation failure can also be effect the overall stability of the structure so that it is liable to slide, to lift vertically or over turn.

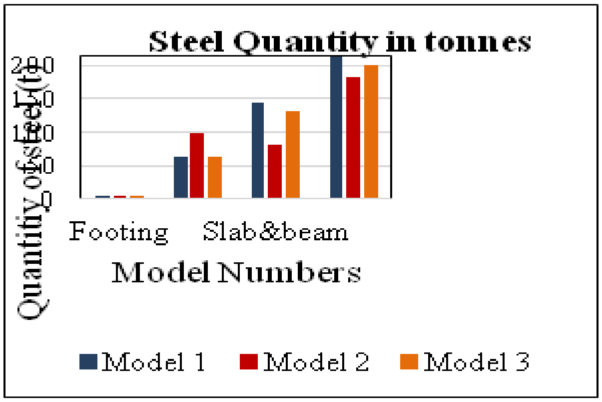
Footing or foundation is defined as the part of substructure, which transmits the loads form the super-structure to surrounding soil stratum safely. Foundations are classified as two types.

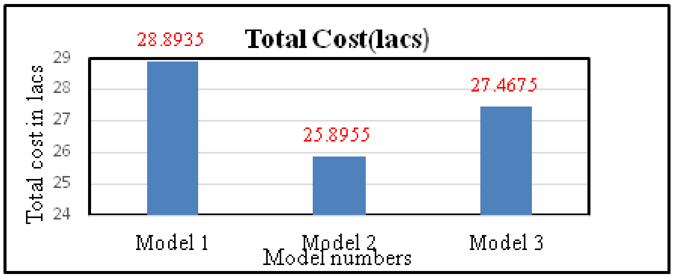
i. Shallow foundation
ii. Deep foundation

The depth of foundation is less than or equal to the width of the foundation then the foundation is said to be shallow foundation. If the depth of the foundation is greater than width of the foundation is said to be deep foundation.
The footings are classified as follows:

a. **Isolated** under individual column. These may be square, rectangular or circular in plan.
b. **Strip footing and wall footing.**
c. **Combine footing**, supporting two or more loads these may be rectangular or trapezoidal in plan or they may be isolated beam basis join by a beam. The latter case is referred to as foot strapping.
d. **Raft or mat foundation** is a large continuous foundation supporting on the column of structure. This is normally used when soil conditions are poor or differential settlement is to be provided. columns.several columns or loads leaving columns.







IV. CONCLUSIONS

1. In shuttering consumption of materials is lowest 10311 sq.m for model -2 there by it gives lowest cost of Rs.2,57,700/- and consumption of material is more15606 sq.m for model – 3 there by it gives highest cost of Rs. 3,90,000 /- ,comparing the two models cost of shuttering is decreased as 51.33% model-2.
2. The cost of shuttering per m^2 floor area is 44.09/-for model-1,34.977/- for model-2 and 52.93/- for model-3.
3. Quantity of concrete consumption is less for model-3 of 1775 m^3 and more for model-1 of1975$m^{3.}$ There by model-3 gives lowest cost of Rs .11,53,750/- and thereby for model – 1 has highest cost of Rs12,83,750 /- ,comparing the two models cost of concrete is decreased as 20% for model-3
4. The cost of concrete per m^2 floor area is 1742.4/-for model-1, 1666.55/- for model-2 and 1565.98/- for model-3.
5. Consumption of steel is maximum in model-1 of 213.45t and less for model 2 of 184t .There by cost of model2 is less cost of Rs. 11,04,000 /- and model1 is more cost of Rs 12,80,700 /-, comparing the two models cost of steel is decreased as 13.79% for model-2.
6. The cost of concrete per m^2 floor area is 1738.29/-for model-1, 1498.84/- for model-2 and 1632.82/- for model-3.
7. Flat slab system (Model-2), provides most economical configuration with internal columns. The total estimated cost of construction is Rs 25,89,550/-
8. Framed structure system (Model-1) provides least economical configuration. The total estimated cost of construction is Rs 29, 89,355/-.
9. The total cost of construction per m^2 floor area is 3921.7/- for model-1, 3514.79/- for model-2 and 3728.15/- for model-3.
10. By comparing the all models total cost of construction is decreased as 13.83% for model-2 and 4.93% for model-3.

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