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ANALYSIS AND DESIGN OF RESIDENTIAL BUILDING WITH FLOATING COLUMN

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Abstract – *In the modern era of Construction multi-storied building with floating column plays a major role in urban cities of India. These floating columns are used mainly for satisfying the space requirement in the structure and to get good architectural view of the building. A residential multi-storied building consisting of G+6 has been chosen for carrying out project work. The work was carried out considering different cases of removal of columns in different positions and in different floors of the building. The above building models are generated using the software E-TABs 2015 and are analyzed and designed by using IS 456-2000 guidelines.*

Key Words: **Floating columns, E-TABs, RCC frames, Building Analysis, Bending moment, Shear force**

1. INTRODUCTION

In the present day, constructions of buildings in urban cities in India, the main problem arises in the accommodation of parking areas, reception lobbies etc. To overcome this problem floating columns came into existence and now it has become an unavoidable feature in most of the multi-storied buildings from foundation level and transferring the load to the ground. The term floating column is also a vertical element which (due to architectural design/site situation) at its lower level (termination level) rests on a beam which is a horizontal member. The beams transfer the load to the other columns below it. There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. These open spaces may be required for assembly hall or parking purpose. The transfer girders have to be designed and detailed properly. The floating column act as a point load on the beam and this beam transfers the load to the columns below it as far as analysis is concerned, the column is often assumed pinned at the base and is therefore taken as a point load on the transfer beam. The floating column is a vertical member which rest on a beam and doesn't have a foundation. But such column cannot be implemented easily to construct practically since the true columns below the termination level are not constructed with care and hence finally cause to failure.

Buildings with floating columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path. The floating column is used for the purpose of architectural view and site situations. It can be analysed by using E-TABs. The provisions of floating columns can be stated as most of the buildings in India are covering the maximum possible area on a plot within the available bylaws.

1.1 Floating Column

The floating column is a vertical member which rest on a beam but doesn't transfer the load directly to the foundation. The floating column acts as appoint load on the beam and this beam transfers the load to the column below it. The column may start off on the first or second or any other intermediate floor while resting on a beam. Usually columns rest on the foundation to transfer load from slabs and beams. But the floating column rest on beam. The floating column in a building as shown in Fig.1

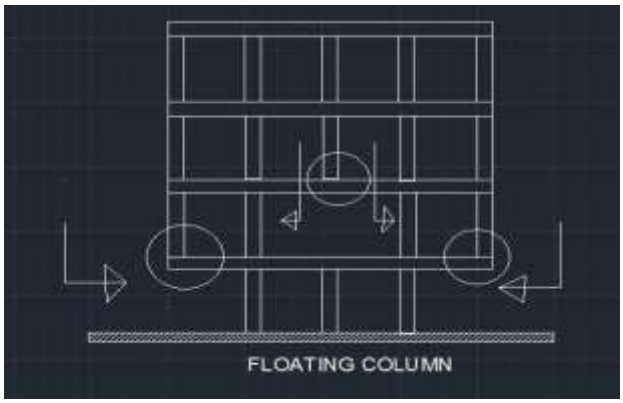

Fig.1. Floating column in Building

In modern times the buildings are becoming complex particularly the mix use ones. There are different uses on different floors and hence to follow it structural grid becomes difficult as columns on any floor would become a hindrance. Even in residential buildings when there is a parking on ground floor or lower stories or huge cantilevers are taken to exploit ambiguities in local bylaws for gaining more free spaces, the lower floors need column-free spaces for easy movement of vehicles; while on upper floors which are more in number of the columns have been designed based on room layout. They are also frequently used when there are shops on ground floor and residence on upper floors. Rather than finding an architectural solution one easily take recourse to floating columns and remove columns on lower stories, which is a dangerous proposal.

1.2 TRANSFER BEAM

Transfer beams are required at places where column locations are changing, and to transfer the forces from column above to column below.

To design the transfer beams, consider the point loads at the locations where the columns are stopping. This point load will actually to be equal to the magnitude of the column reactions. Add the other loads which might act on the beam (self-weight, live load acting on the beam). Then check for shear and flexure, similar to a normal beam.

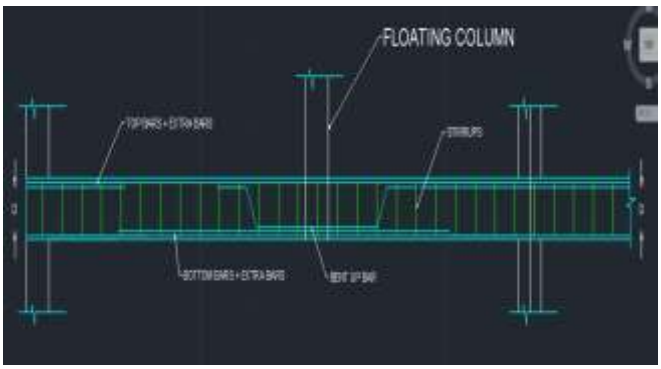

Fig.2. Transfer beam which support Floating Column

2. OBJECTIVES AND SCOPE OF WORK

The objective of the present work is to study the behavior of multistory buildings with floating columns. The base of the building frame is assumed to be fixed. Usually all multistoried buildings are of 3 types they are

- Load bearing construction
- Framed construction
- Composite construction

But among the above 3 types, in the present stage all the multistoried structure are framed construction which are durable. An engineering structure is an assembly of member of elements transferring the loads and providing a firm space to serve the desired foundation. The structural design is a science and art of designing, with economy and elegance, a durable structure is that which can safely carry the forces and can serve the desired function satisfactorily during its expected service life span. The entire process of structural planning and designing requires not only imagination and conceptual thinking but of practical aspects, such as relevant design codes and bylaws, backed up by ample experience, institutions and judgment. The process of design commences with planning of a structure, primarily to meet the functional equipment of the user or client. The functional requirements and the aspects of the aesthetics looked in to normally by an architect while the aspect of safety, serviceability, durability and economy of the structure for its intended use over the life span.

3. METHODOLOGY

With reference to the national building code, plan for the building is made, and models are made. Analysis and design is done by using structural software E-TABs 2015. The design of RCC structural elements are carried out by considering the minimum dimensions of column, beam and slab. The dimensions of RCC structure elements are designed using MS EXCEL (spread sheet) by considering the various loads such as Live load, Dead load and Wind load. The design is carried as per the code i.e., IS 456-2000.

3.1 MODEL FORMULATION

The study is carried out on a building with floating columns. The plan layout of the building is shown in the figure. The building is considered as residential building having G+6. Height of each storey is kept same as other prevalent data.

3.2 REASERACH SIGNIFICANCE

In urban areas, multi storey buildings are constructed by providing floating column for the various purposes which are stated above. These floating column buildings are not designated for earthquake loads. So these buildings are not designed for earthquake loads. So these buildings are unsafe in seismic prone areas. The project aims to create awareness about these issues in earthquake resistant design of multi-storey buildings.

3.3 LIMIT STATE METHOD

In the limit state design method, non-deterministic parameters are determined based on observations taken over a period of time. The objective of design based on the limit state concept is to achieve an acceptable probability that a structure will not become unserviceable in its life time for the use for which it is intended, that is, it will not reach a limit state. A structure with appropriate degrees of reliability should be able to withstand safely all loads that are liable to act on it throughout its life and it should also satisfy the serviceability requirements such as limitations on deflection and cracking. It should also be able to maintain the required structural integrity during and after accidents such as fires, explosions and local failure. Due to its realistic approach, limit state method is used in design of structures. The most important limit states which must be examined in design are as follows:

3.3.1 LIMIT STATE OF COLLAPSE

This state corresponds to the maximum load carrying capacity; violation of collapse limit state implies failure in the sense that a clearly defined limit state of structural usefulness has been exceeded. However, it does not mean a complete collapse. Thus limit state may correspond to:

- Flexure
- Compression
- Shear
- Torsion

3.3.2 LIMIT STATE OF SERVICEABILITY

This state corresponds to development of excessive deformation and is used for checking members in which magnitude of deformations may limit the use of the structure or it is components. This limit state may correspond to:

- Deflection
- Cracking
- Vibration

3.4 MODELING OF BUILDING

The residential building (G+6) with floating columns were selected for the study. The building is considered to be located in Zone III (Bhatkal) as per IS 1893-2002.

The building is modeled using the structural software E-TABs 2015. The analytical models of the building include all the component that influence the mass, strength, stiffness and durability of structure. The building structural system consists of beam, column, floating column, slab, grid slab, foundation, shear wall and staircase.

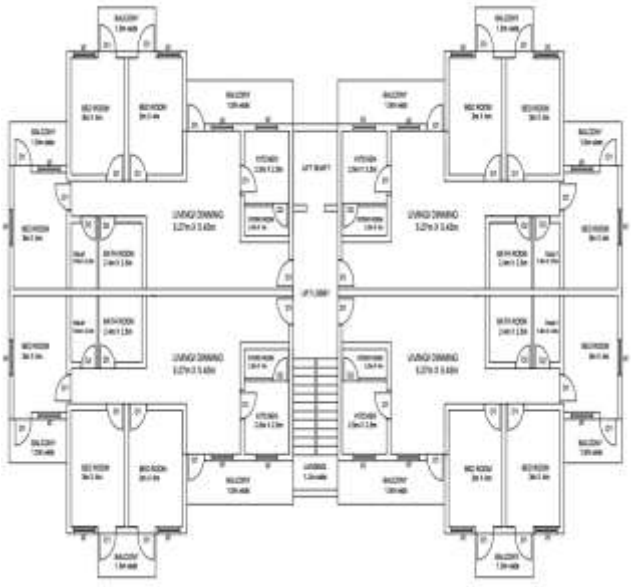

Fig.3. Typical floor plan

Fig.4. 3D Model of the Building

3.4.1 DESCRIPTION OF THE BUILDING

- Floor area = 521 m^2
- Number of floor = G+6
- Number of flat in each floor = 4
- Number of rooms in each flat = 3
- Floor to floor height = 3.6m
- Number of staircase = 1
- Number of lifts = 1
- Types of footing = Isolated footing
- Party hall & Gym at top floor

Table – 1: Structural element with Properties

RCC Member	Properties	
	Grade of Concrete	Size in mm
Columns	M30	230X600
		230X750
		230X900
Beams	M30	230X450
		230X600
		230X750
Slab	M30	125

3.5 TYPES OF LOADS

Various types of loads on a structures and requiring in consideration in design are,

- Dead load
- Live load
- Wind load

3.6 LIST OF IS CODE USED IN ANALYSIS AND DESIGN

- IS 456-2000 Plain and Reinforced concrete
- IS-SP-16:1980 for R.C Column Design
- IS 875-1987 Part-I for Dead Load
- IS 875-1987 Part-II for Live Load
- IS 875-1987 Part-III for Wind Load

3.7 LOAD COMBINATION

A load combination results when more than one load type acts on the structure. Building codes usually specify a variety of load combinations together with load factors(weightings) for each load type in order to ensure the safety of the structure under different maximum expected loading scenarios.

Load combinations used in the design are,

- 1.5(DL+LL)
- 1.2(DL+LL+WL)

4. ANALYSIS & DESIGN

The project requires the analysis of the building in order to find out the magnitude of loads and their distribution. Hence, the software has been used for the analysis was E-TABs 2015. The building was modeled with all the structural element and floating column. The various loads that would act on the structure were defined along with the properties of the structural elements. The analysis was carried out and the loads and the moments were determined. After which the structural elements are designed manually and have been checked for safety.

5. RESULTS & DISCUSSION

5.1 BENDING MOMENT

The BMD of beams for the G+6 storied frame structure is as shown in the Fig.6. It is observed that the bending moment is greater at mid span of each beam and reduces linearly as it proceeds towards the support of the beam span.

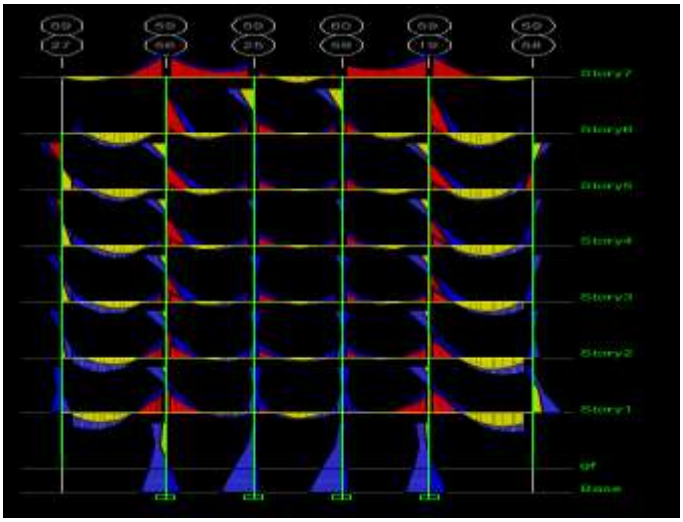

Fig.5. Bending Moment

5.2 SHEAR FORCE

The SFD for the desired multi storied structure is as shown in Fig.6. It is observed that the shear force is greater towards the end portions of the beams that is towards the joint pertaining a beam and column. Shear force may also occur in a beam to beam junction.

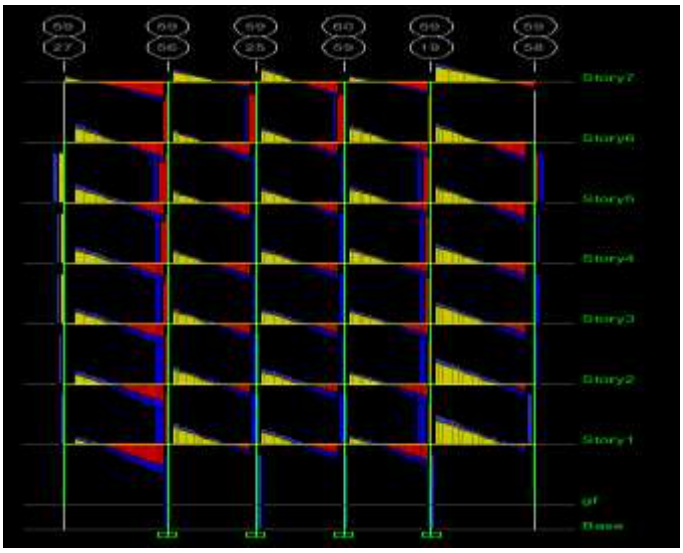

Fig.6. Shear Force

5.3 FOOTING REACTIONS

The below fig.7.shows the vertical load along the column of the structure to the base of the footing. These footing loads are used to determine the type of footings corresponding to the soil condition and seismology. These column loads are grouped and used to design a combined footing.

Fig.7. Reactions & Moment for Footing

5.4 ESTIMATION OF THE PROJECT

Table – 2: Plinth Area Rate

Total cost of the project(INR)	Area of the building In Sq.ft.	Plinth area rate per Sq.ft
7,15,50,000	5608	1823

6. CONCLUSIONS

Based on the test result, the following conclusions were made:

- Building provided with the floating column shows more storey drift & storey displacement as compare to building without floating column.
- The optimum position to provide floating column is at 1st floor alternatively so that moment, shear & steel requirement of the whole building can be minimized.
- Hence provide the floating column is advantageous in providing good floor space index but risky & vulnerability of the building increases.
- The use of floating column in modern building are increasing vastly

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BIOGRAPHIES

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