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Comparative Study of Seismic Behaviour and Cost Comparison of Multi-Storey Flat Slab and Conventional Reinforced Concrete Framed Structure

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ABSTRACT

Flat slabs system of construction is one in which the beams used in the conventional methods of constructions are done away with. The slab directly rests on the column and load from the slab is directly transferred to the columns and then to the foundation. Comparison of flat slab with drop, flat slab without drop and grid slab for its behaviour during earthquake and after earthquake should be help to choose the slab for long span or long panel of slab. This comparison is also help to get or find out more economical slab for long span or long panel. Main object or aim of this comparison is to use this result in future to get more economical and more strengthen slab for long span or long panel. In this project a humble attempt is made to comparative study of Flat slab with drop, flat slab without drop and grid slab for same span and same panel size. These types of Slab have been analysed and designed by ETABS software.

Keywords: R.C.C, Flat slab with or without drop, strengthening and Concrete, Rate analysis per sq m, Etabs software.

I. INTRODUCTION

A concrete slab reinforced in two or more directions, generally with drop panels at supports, but without beams or girder.

Reinforced - concrete floor construction not requiring beams and girders to transmit the floor load to supporting columns

Reinforced concrete flat slabs are one of the most popular floor systems used in residential buildings, car parks and many other structures.

They represent elegant and easy-to-construct floor systems. Flat slabs are favoured by both architects and clients because of their aesthetic appeal and economic advantage.

A flat slab floor system is often the choice when it comes to heavier loads such as multi- story car parking, libraries and multi- story buildings where larger spans are also required.

Slabs of constant thickness which do not have drop panels or column capitals are referred to as flat plates. The strength of the flat plate structure is often limited due to punching shear action around columns, and consequently they are used for light loads and relatively small pans.

According to Park.E.H.Kim et al and Y. H. Luo, A. Durrani the most important advantages offered by are as follows:

- By comparison with reinforced concrete, a considerable saving in concrete and steel since, due to the working of the entire concrete cross-section more slender designs are possible.
- Smaller deflections compared to with steel and reinforced concrete structures.
- Good crack behavior and therefore permanent protection of the steel against corrosion.
- Almost unchanged serviceability even after considerable overload, since temporary cracks close again after the overload has disappeared.
- High fatigue strength, since the amplitude of the stress changes in the prestressing steel under alternating loads are quite small.

For the above reasons flat slab construction has also come to be used in many situations in buildings. In addition to the above mentioned general features of flat slab construction systems, the following advantages of flat slabs over reinforced concrete slabs are listed as follows:

- More economical structures resulting from the use of prestressing steels with a very high tensile strength instead of normal reinforcing steels.
- Larger spans and greater slenderness, which results in reduced dead load, which also has a beneficial effect upon the columns and foundations and reduces the overall height of buildings or enables additional floors to be incorporated in buildings of a given height.

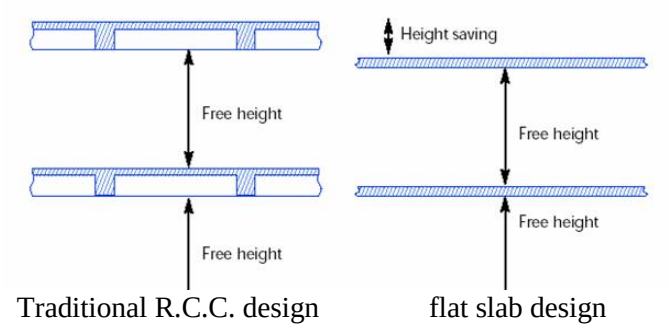

Figure 1: Height comparison of R.C.C. & slab design [3]

II. METHODS AND MATERIAL

A. Scope of Study

Of all Structural costs, floor framing is usually the largest component. Likewise, the majority of a structure's formwork cost is usually associated with the horizontal elements. Consequently, the first priority in designing for economy is selecting the structural system that offers lowest overall cost while meeting load requirements. For the study of flat slab with drop, flat slab without drop and grid slab is taken and it is designed by three cases, effect of the earthquake on flat slab with drop, without drop and grid slab. After the design of these three cases the comparative study with respect to the economy is carried out.

Hence, the present study aims to compare the cost effectiveness of flat slab systems with reinforced concrete flat slab systems. For this purpose, a multistorey building with both the slab systems with different panels was considered. Finally, cost comparison graphs are plotted for RCC and flat slab systems with respect to span of the member.

B. Comparative Study

For the study of flat slab with drop, flat slab without drop and grid slab is taken and it is designed by three cases, effect of the earthquake on flat slab with drop, without drop and grid slab. After the design of these three cases the comparative study with respect to the economy is carried out.

Story height:	3m
Storey:	G+4
No of bay:	4
Panel sizes:	7x7m(4)
Concrete grade for RCC and PT	
Flat Slab:	M25
Beam and Slab:	M25
Concrete grade for PT:	M25
Strength of steel in RCC:	500 N/mm^2

The above mentioned floor systems of r.c.c and Post Tensioning are analyzed using Etabs are done according to the specifications given in IS456:2000, IS 1343: 1980 respectively.

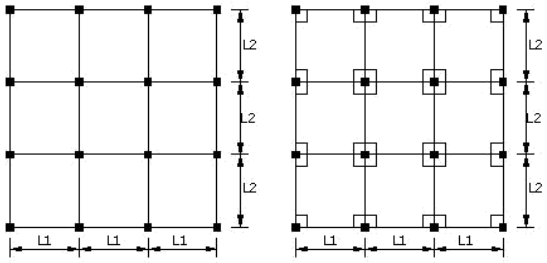

Figure 2: Plan of slab with drop and without drop
Where, L1 and L2 are panel sizes

C. Analytical Study

Flat slab without drop and flat slab with drop in concrete are widely used because of their economy and fast construction, especially for buildings with long spans. The analysis and design of such slabs are complicated and time consuming. Therefore, in the present study ETABs software is used to analyze rcc and flat slabs. Subsequently, rcc flat slabs were designed and checked using Etabs software. The details of the reinforcements are obtained from these designs and they are converted in quantities and corresponding cost for each system is calculated. Finally, the cost comparison graphs are generated for rcc and flat slab with or without drop. The typical view of the flat slab panel.

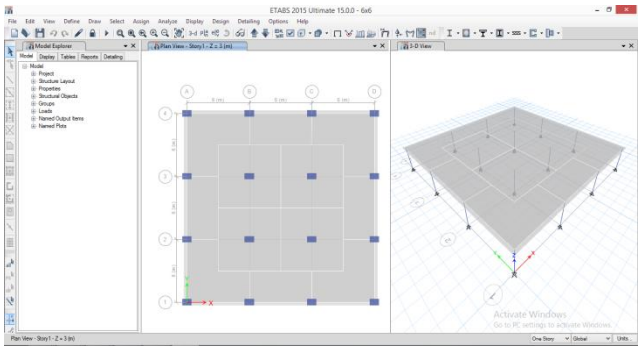

Figure 3: The typical view of the (7×7) m panel in Etabs

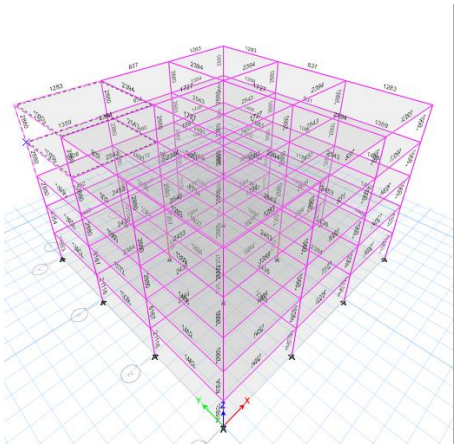

Figure 4: Analysis of g+4 building (different model, flat slab with drop without drop and rcc grid slab)

D. Estimating And Costing

From the analysis and design results of the panel the total estimation for the quantities for a typical floor is calculated. The quantities of concrete, reinforcing steel, and the formwork and their cost according to the current rate excluding the labour charges for the r.c.c flat slab, flat slab without drop and flat slab with drop are given in the table. Rates are taken from Surat Urban Development Authority (SUDA 2015).
(Rate of concrete=4400/-per m^3, Rate of steel=50/-per kg, Rate of form work=400/- per m^2).

Table 1: The quantities of steel

Type of slab	Steel (kg)
Grid slab	42179.20
Flat slab without drop	40182.31
Flat slab with drop	38089.52

Table 2: The quantities of concrete

Type of slab	Concrete
Grid slab	210.53
Flat slab without drop	193.68
Flat slab with drop	185.92

Table 3: rate comparison of steel

Type of slab	Cost of steel (Rs.)
Grid slab	1476272
Flat slab without drop	1406380.85
Flat slab with drop	1333133.2

Table 4: rate per sq meter

Type of slab	Rate per. Sq. meter
Grid slab	3996
Flat slab without drop	3785
Flat slab with drop	3452

III. RESULTS AND CONCLUTION

The analysis, design and the estimation of the flat slab without drop flat slab with drop and rcc grid slab is carried our finally. the thickness of this different slab sizes are found out. From the analysis and design carried out that flat slab with drop is require less thickness compare to other.

1. From the economic point of view the flat slab with drop is the most economical compare to the flat slab without drop and rcc grid slab.
2. If we consider the flat slab without drop and reinforced concrete flat slab, the flat slab with drop and the flat slab without drop, the thickness of reinforced concrete flat slab are 22% and 32% greater respectively and its cost are 25% and 27% greater respectively.
3. For the increase in the panel sizes, the cost is also increasing gradually.
4. The purely flat slab RC structural system is considerably more flexible for horizontal loads than the traditional RC frame structure which contributes to the increase of its vulnerability to seismic effects.
5. Concrete required in grid slab is more as compared to flat slab without drop and flat slab with drop.
6. Flat slab with drop is more economical than flat slab without drop and grid slab.

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