International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

Nonlinear Behavior of Flat Slab using Shear Wall

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ABSTRACT: ***Flat slab is a reinforced concrete slab supported directly by concrete columns without the use of beams .However; in multi-storey buildings it has weak resistance to the lateral loads. Hence this work is concerned to decrease the damage under lateral loading and to minimize the displacement. Shear wall are used to provide stability to structures from lateral loads. The aim of the present study is to analyze effect of shear wall and perimeter beam for flat slab building, and also effectiveness of core shear wall. For present work five models are studied 1) conventional slab building 2) simple flat slab building considered without any drop and column head 3) flat slab with drop building is considered without column head 4) flat slab with drop with perimeter beam building 5) flat slab with perimeter beam and shear wall buildings, each of plan size 25mX25m are selected. For stabilization of structural parameters, shear wall are provided. The seismic parametric studies comprise of roof displacement, base shear, and sequence of hinge formation .from study it concluded that the shear walls significantly increases the base shear capacity and reduces roof displacement and also getting good Performance***

Keywords: conventional slab building, flat slab building, drop panel, Perimeter beams, shear wall, pushover analysis

I. INTRODUCTION

Flat slab is a reinforced concrete slab which is supported directly by concrete columns without beams and directly transfers the load to column without beams and then to foundation. This type of slab favored by both clients and architects for their aesthetic appeal because of the beams net ceiling height reduces. This type of slab mostly used to avoid the beam-column clogging and easy to construct floor systems and it is very economical Because of absence of deep beam flat slab building structures are more significantly flexible than conventional concrete structures, thus becoming more vulnerable to seismic loading. Thus the seismic analysis of these structures is necessary to know the vulnerability of these structures to seismic loading.

Revised Manuscript Received on October 30, 2019.
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Flat slab is defined as one sided or two-sided support system with shear load of the slab being concentrated on the supporting columns and a square slab called drop panels. Drop panels play a significant role here as they augment the overall capacity and sturdiness of the flooring system beneath the vertical loads thereby boosting cost effectiveness of the construction. Usually the height of drop panels is about two times the height of slab.

But the major disadvantage of flat slab is its high flexibility due to which many problems like motion sickness, high storey displacement etc occurs so to overcome this the concept of Perimeter beams is adopted which reduces the flexibility of the flat slab structure to a much greater extend. Due to the flexibility of Flat slab structures, they must be made stiffer or their rigidity must be increased by any means. Perimeter beams or Edge beams are provided with flat slabs for increasing their stiffness and for withstanding the lateral loads in high seismic zones. It has been learnt from past experiences that the shear wall buildings exhibit excellent performance during the severe ground motion due to stiff behavior at service loads and ductile behavior at higher loads thus preventing the major damage to the RC buildings Shear wall are used to provide stability to structures from seismic loads. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal load and support gravity load. To resist lateral force due to wind and earthquakes R.C shear walls are used in buildings

II. OBJECTIVE OF THE STUDY

The objectives of the present study are-

- The main objective of the present work is to study the behaviour of flat slab with drop and perimeter beam buildings with effectiveness of shear wall using ETABS 2017.
- Non linear static analyses are performed on the models to find various seismic parameters like: Base Shear, Displacement and sequence plastic hinge formations

III. ANALYTICAL STUDY

A) Modelling and material properties:-

In this work, five models are considered to understand the seismic behavior of RC flat slab. The buildings frames are assumed to be located in Indian seismic zone V with type II soil conditions. A 10 Storey model of plan dimension 25mx25m consists of building models, building details, loads and load combinations. The characteristic strength of concrete M25 and steel were taken as Fe500. Non linear analysis is carried out and results were compared

Table 3.1 building models

BUILDING MODEL	DESCRIPTION
1	RC Conventional Slab Frame Building
2	Simple Flat Slab Building
3	Flat Slab with Drop Building
4	Flat Slab with Drop with Perimeter Beam
5	Flat Slab with Perimeter Beam and Shear Wall

Table 3.2 Details of structural elements and materials used

Plan dimension	25m X 25m
Column size	700mm X 700mm
Slab thickness	200mm
Floor to floor height	3m
Beam size	350mm X 350mm
Drop thickness	100mm
Drop size	2m X 2m
Grade of concrete	M25
Grade of steel	Fe 500
No of storeys	10
No of bays in x-direction	5
No of bays in y-direction	5
Bay width in x-direction	5m
Bay width in y-direction	5m
Live load	3 KN/m^2
Shear wall thickness	200mm
Response reduction factor	5
Importance factor I	1
Soil type	II – MEDIUM

B) Load combinations

Following load combinations with the appropriate partial safety factor satisfying IS code provision i.e.IS 456:2000, table 18, clause 18.2.3.1 and IS 1893:2002, clauses 6.3.2.1 are as follows:-

1. 1.5(DL + LL)
2. 1.2(DL + LL + EQX)
3. 1.2(DL + LL - EQX)
4. 1.2(DL + LL + EQY)
5. 1.2(DL + LL - EQY)
6. 1.5(DL + EQX)
7. 1.5(DL - EQX)
8. 1.5(DL + EQY)
9. 1.5(DL - EQY)
10. 0.9DL + 1.5EQX
11. 0.9DL - 1.5EQX
12. 0.9DL + 1.5EQY
13. 0.9DL - 1.5EQY

C) Building models

In this work, five models are considered to understand the non linear behavior of flat slab. The models consist of (1) conventional slab (2) simple flat slab, (3) flat slab with drop, (4) flat slab with perimeter beam, (5) flat slab with shear wall and perimeter beam. The models consist of 10 story buildings with 5 bays in each direction

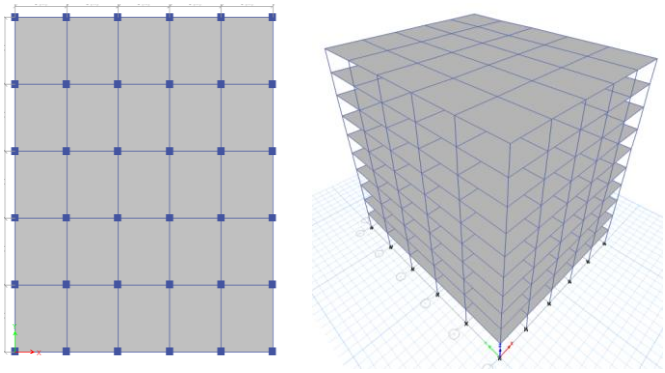

Figure-3.1: Plan and 3-D view of proposed conventional slab building

Figure 3.1 shows plan and 3-D view of 10 storey RC conventional frame slab building is supported with beams and column with fixed end at bottom .The load is transfers from slab to beam.

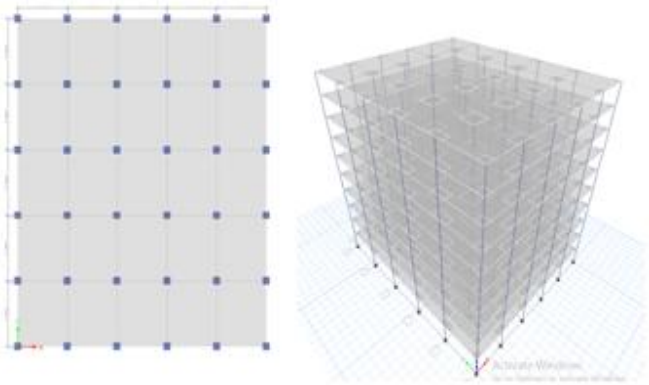

Figure-3.2: Plan and 3-D view of proposed flat slab building

Figure 3 shows plan and 3-D view of 10 storey reinforced concrete simple flat slab building with fixed end at bottom,. The slab directly rest on column which means the load from slab directly transformed to column and then to foundation. Thickness of slab is more.

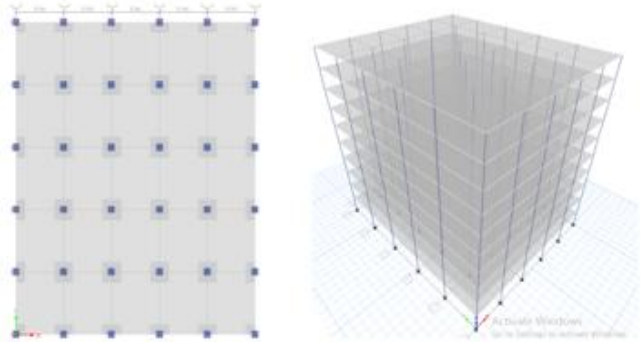

Figure-3.3: Plan and 3-D View of proposed building of flat slab with drop

Above Figure 3.3 shows plan and 3-D view of 10 storey reinforced concrete flat slab with drop building with fixed end at bottom .The portion of flat slab that is thickened throughout surrounding the top of column. Auto hinges are assigning to only columns because beams are not provided

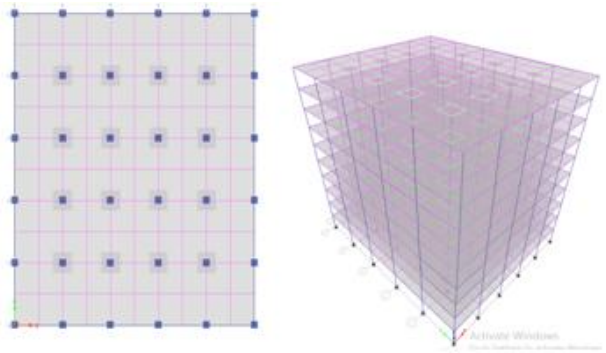

Figure-3.4: Plan and 3-D View of proposed building of flat slab with drop and perimeter beam

Figure 3.4 shows plan and 3-D view of 10 storey reinforced concrete flat slabs with drop with perimeter beam building and with fixed end at bottom. Perimeter beams are provided along periphery of the building.

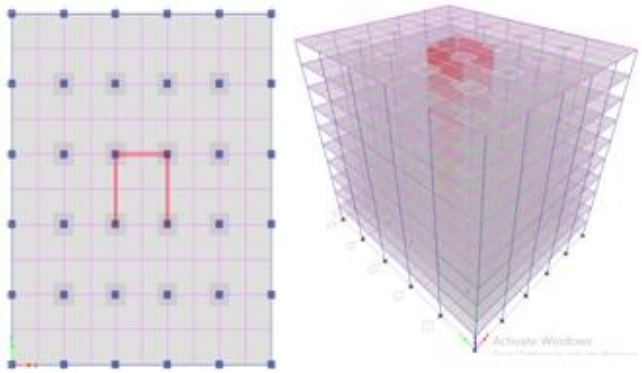

Figure-3.5: Plan and 3-D view of proposed building of flat slab with perimeter beam and core shear wall

Figure 3.5 shows plan and 3-D view 10 storey reinforced concrete flat slabs with perimeter beam and shear wall building with fixed end at bottom. Perimeter beam is provided along periphery of building and core shear wall is provided in centre of the building.

IV. RESULTS AND DISCUSSION

A comparison made between building models to know the seismic performance of flat slab building. Non linear static analysis is performed on conventional slab, simple flat slab, and flat slab with drop, flat slab with drop and with perimeter beam and flat slab with perimeter beam and with provision of shear wall

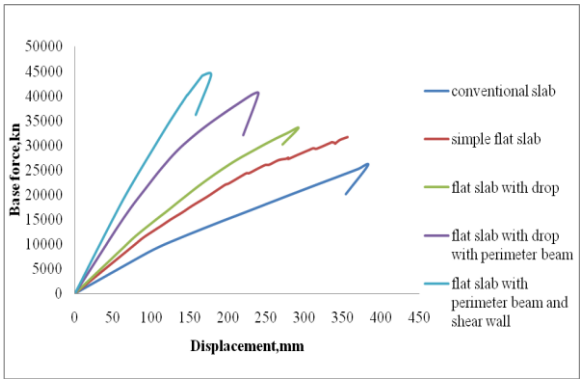

figure 4.1: capacity curve of all frames

figure 4.1 we can observed that as compared to conventional slab ,initially base shear increases in flat slab when compared to conventional slab .

Base shear capacity increases by about 41.4% with provision of shear wall and 53.45% displacement reduces with provision of shear wall.

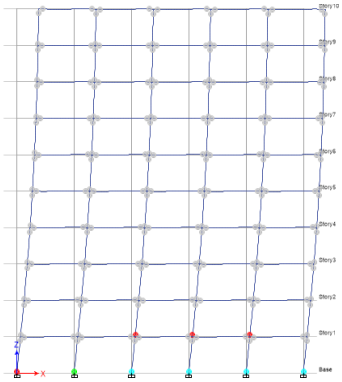

Figure 4.2: hinge formation for convnenional slab frame building

Figure 4.2 shows plastic hinges formation starts at displacement of 132.31mm at base resistance of 10913.45KN at bottom storey column of collapse prevention (CP)

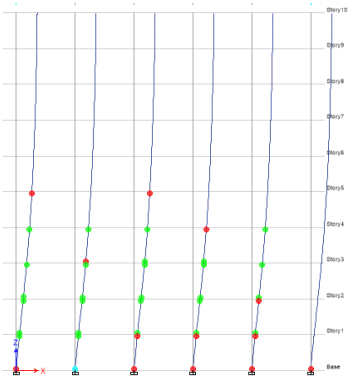

Figure 4.3: hinge formation for flat slab frame building

Figure 4.3 we can say that plastic hinges formation starts at displacement of 60mm at base resistance of 7600.60KN of collapse prevention (CP) at columns base of lower stories,

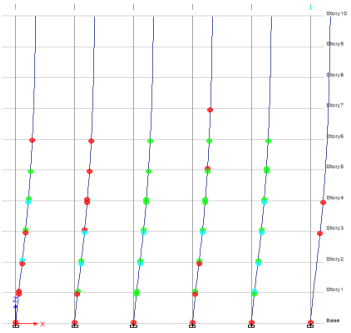

Figure 4.4: hinge formation for flat slab with drop building

From figure 4.4 we can say that plastic hinges formation starts at displacement of 63.6mm at base resistance of 9357.79KN of collapse prevention (CP) at columns base of lower stories.

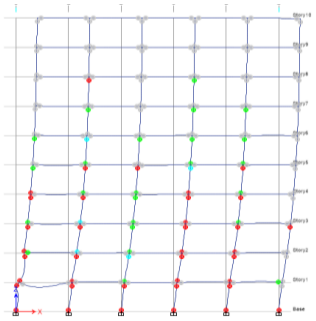

Figure 4.5: hinge formation for flat slab with perimeter beam with drop building

From figure 4.5 we can say that plastic hinges formation starts at displacement of 55.08mm at base resistance of 13317.65KN of collapse prevention (CP) at columns base of lower stories.

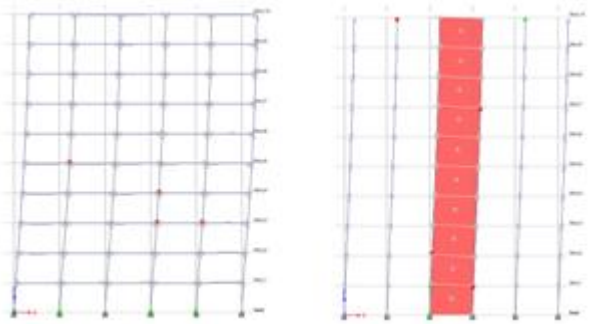

Figure 4.6: hinge formation for flat slab with perimeter beam and shear wall building of elevation view 1 and elevation view 4

From figure 4.6 we can observe that immediate occupancy occur at base level of building near shear wall joint and after that propagates to collapse prevention that occurs near shear wall joint of 1st storey and 2nd storey

Figure 4.6 we can observe that collapse prevention (CP) hinge start forming at a displacement of 158.21mm with base resistance of 36210.54KN at base of columns of 3rd, 4th and 5th storey.

V. CONCLUSION

The following are the major conclusions that are reached from the studies conducted

1) The maximum base shear capacity of simple flat slab increases by about 18% when compared to conventional slab and when comes to displacement there is not much difference just 6.87% variation

2) Flat slab with drop showing base shear capacity 5.54% more than simple flat slab structure and displacement capacity is increased by about 18.11% in simple flat slab when compared to flat slab with drop

3) The maximum base shear capacity of flat slab with perimeter beam and shear wall shows drastically increase up to 41.4% when compared to conventional slab frame building .and maximum reduction in displacement was observed by about 53.45%

4) The flat slab structure with and without the perimeter beam shows variations in base shear carrying capacity up to 17%. Increase in base shear structure is strengthened with perimeter beam and maximum reduction in displacement by about 17.8% strengthened with perimeter beam

5)) A significant variation is observed in hinge formation mechanism in all frame building .And hinge formation start for conventional and flat slab with perimeter beam and shear wall at marginal variation in displacement up to 3.7% more in structure strengthened with shear wall.

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