Seismic Behaviour Of Flat Slab Framed Structure With And Without Masonry Infill Wall

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Abstract

In general normal frame construction utilizes columns, slabs & beams. However it may be possible to undertake construction without providing beams, in such a case the frame system would consist of slab and column without beams. These types of slabs are called Flat slab, since their behavior resembles the bending of at plates. These slab are directly rests on column and the load from the slabs is directly transferred to the columns and then to the foundation. Drops or columns are generally provided with column heads or capitals. The main aim of the project is to determine the Dynamic response of Flat slab with drop and without drop and Conventional Reinforced Concrete Framed Structures for different height with and without masonry infill wall.
Keywords—*Flat slab with drop, Flat slab without drop, conventional building, storey drift, STAAD PRO.*

1. Introduction

Reinforced concrete has been used for building construction since the middle of the 19th century, first for some parts of buildings, and then for the entire building structure. Reinforced concrete is a major construction material for civil infrastructure in current society. Construction has always preceded the development of structural design methodology. Dramatic collapse of buildings has been observed after each disastrous earthquake, resulting in loss of life.

A flat slab is a typical type of construction in which a reinforced slab is built monolithically with the supporting columns and is reinforced in two or more directions, without any provision of beams. The flat slab thus transfers the load directly to the supporting columns suitably spaced below the slab. The flat slab is often thickened closed to supporting columns to provide adequate strength in shear and to reduce the amount of negative reinforcement in the support regions. The thickened portion i.e. the projection below the slab is called drop or drop panel. The perimeter of the critical section, for shear and hence, increasing the capacity of the slab for resisting two-way shear and to reduce negative bending moment at the support.

2. Details of the Structure

A. Modelling and Analysis

The main objective of the analysis is to study the different forces acting on a building. The analysis is carried out in STAAD Pro V8i software. Results of conventional building, flat slab with drop and flat slab without drop for different heights with and without masonry infill wall are discussed below. Conventional building, flat slab with drop and flat slab without drop different height are modelled and analyzed for the different combinations for Dynamic loading. The comparison is made between the Conventional buildings, flat slab with drop and flat slab without drop Buildings with and without masonry infill wall is situated in seismic zone III.

B. Assumptions

The following are the assumptions made:

The heights of the buildings are kept as 17.5 m, 25 m and 32.5 m, from ground these buildings are of 5 storeys, 7 storeys and 9 storeys, respectively. The height of one floor is of 3.6m each. In this way the 9 number of total modal are analyzed.

C. Group Properties

The different components of Conventional Building are as follows.

Columns of the building is of 600mm x 600mm

Beam size of the building is of 230mm x 600mm

Slab thickness of the building is of 150mm

Similarly the different components of Flat slab with drop and without drop are as follows.

Columns of the building is of 600mm x 600mm

Slab thickness of the Flat slab without drop building is of 200mm.

Size of Drop in 300mm.

Wall thickness of 230mm.

Material properties : M_{25}

$$E_c = 5000\sqrt{f_{ck}}$$

D. Data for Infilled Frame

Infill properties

Elastic modulus of masonry wall (E_m) = 13800 N/mm^2

Thickness of the infill wall (t) = 230 mm
Height of the infill wall (h) = 3000 mm
Length of the infill wall (L) = 4400 mm
I_c = 5.20x109 mm^4
I_b = 4.14 x109mm^4
$\theta = \tan^{-1}$ (h/L)
= $\tan^{-1}$[3000/4000]
= 34.28

$$\alpha_h = \frac{\pi}{2}\sqrt[4]{\frac{4E_f I_c h}{E_m t \sin 2\theta}}$$

=1.124m

$$\alpha_L = \pi\sqrt[4]{\frac{4E_f I_b h}{E_m t \sin 2\theta}}$$

= 1.656m

$$w = \frac{1}{2}\sqrt{\alpha_h^2 + \alpha_L^2}$$

=1.01m

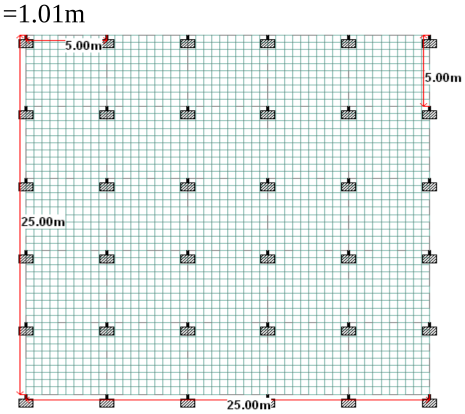

Figure 2.1 Plan of building

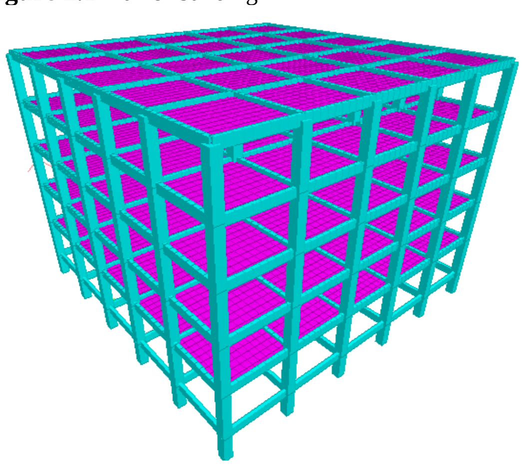

Figure 2.2 Model of Conventional building without Masonry Infill Wall

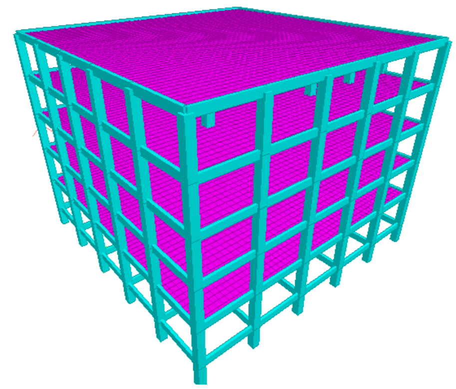

Figure 2.3 Model of Flat Slab building without Masonry Infill Wall

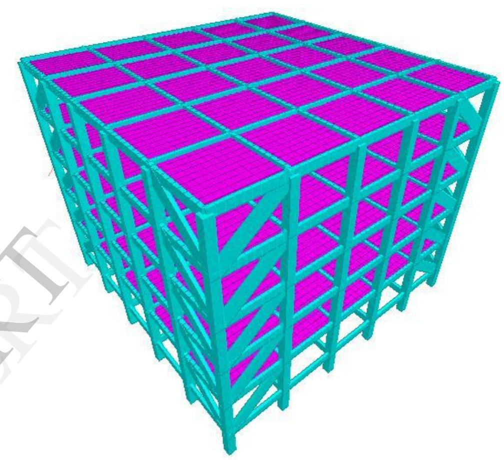

Figure 2.4 Model of Conventional building with Masonry Infill Wall

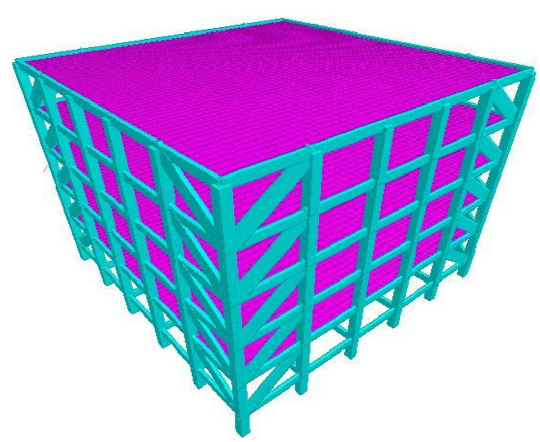

Figure 2.5 Model of Flat Slab building with Masonry Infill Wall

3. Description for Loading

The loading on the buildings is considered as per following calculations

1) Dead Loads

i. Wall load with 230mm thickness = 13.8kN /m.

ii. Wall load with 230mm thickness for parapet = 6.9 kN /m.

iii. Floor finish : 1.5kN/m²

iv. Self weight of building is automatically considered by the STAAD Pro V8i software.

2) Live Loads : 4.0kN/m² at typical floor
: 1.5kN/m² on terrace

3) Earthquake Forces Data

Earthquake load for the building has been calculated as per IS-1893-2002:

i. Zone (Z) = III
ii. Response Reduction Factor (RF) = 3
iii. Importance Factor (I) = 1.5
iv. Rock and soil site factor (SS) = 1
v. Type of Structures = 1
vi. Damping Ratio (DM) = 0.05

4. Results and Discussions

Dynamic analysis for different types of building is done by using Response Spectrum method for earthquake zone III as per Indian Standard code. The effect of Flat slab with drop and Flat slab without drop considering with and without masonry infill wall is evaluated. In the present work significant change in the seismic parameters such as Fundamental Natural Period, Design Base Shear, Displacement and Axial Force of the structure is noticed.

Table 4.1 Design base shear for different type of buildings.

	TYPE OF MODEL	SLAB WITHOUT INFILL WALL	SLAB WITH INFILL WALL	% VARIATION
5 STOREY	CONVENTIONALBUILDING	2351.01	2415.43	2.74
	FLAT SLAB WITHOUT DROP	2376.63	2441.27	2.72
	FLAT SLAB WITH DROP	2535.11	2599.69	2.55
7 STOREY	CONVENTIONALBUILDING	2594.09	2659.89	2.54
	FLAT SLAB WITHOUT DROP	2622.92	2694.67	2.74
	FLAT SLAB WITH DROP	2799.15	2870.89	2.56
9 STOREY	CONVENTIONALBUILDING	2780.14	2857.09	2.77
	FLAT SLAB WITHOUT DROP	2810.80	2887.71	2.74
	FLAT SLAB WITH DROP	3000.67	3077.85	2.57

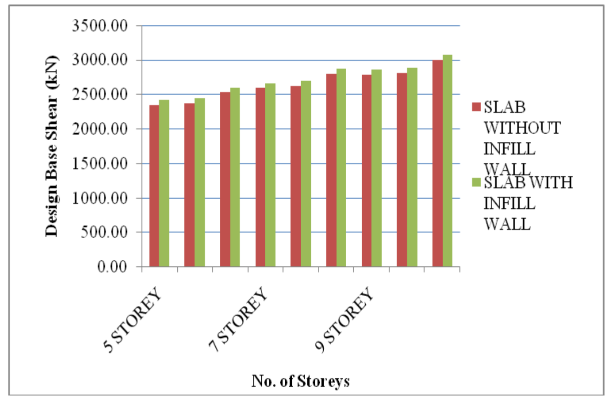

Fig 4.1 Design base shear for different type of buildings without and with infill wall.

Table 4.2 Maximum Displacement for different type of buildings.

	TYPE OF MODEL	SLAB WITHOUT INFILL WALL	SLAB WITH INFILL WALL	% VARIATION
5 STOREY	CONVENTIONALBUILDING	27.971	23.446	19.300
	FLAT SLAB WITHOUT DROP	49.836	30.703	62.316
	FLAT SLAB WITH DROP	41.918	25.645	63.455
7 STOREY	CONVENTIONALBUILDING	41.373	37.581	10.090
	FLAT SLAB WITHOUT DROP	81.388	50.930	59.804
	FLAT SLAB WITH DROP	66.883	41.552	60.962
9 STOREY	CONVENTIONALBUILDING	58.134	46.211	25.801
	FLAT SLAB WITHOUT DROP	118.167	74.820	57.935
	FLAT SLAB WITH DROP	81.381	59.985	35.669

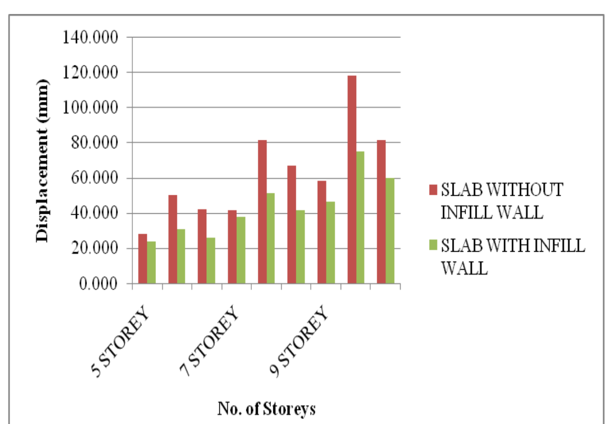

Fig 4.2 Maximum Displacement for different type of buildings without and with infill wall.

Table 4.3 Fundamental Natural Period for different type of buildings.

	TYPE OF MODEL	SLAB WITHOUT INFILL WALL	SLAB WITH INFILL WALL	% VARIATION
5 STOREY	CONVENTIONALBUILDING	0.870	0.759	14.63
	FLAT SLAB WITHOUT DROP	1.134	0.920	23.28
	FLAT SLAB WITH DROP	1.016	0.856	18.69
7 STOREY	CONVENTIONALBUILDING	1.216	1.065	14.22
	FLAT SLAB WITHOUT DROP	1.644	1.273	29.16
	FLAT SLAB WITH DROP	1.432	1.210	18.37
9 STOREY	CONVENTIONALBUILDING	1.567	1.382	13.39
	FLAT SLAB WITHOUT DROP	2.183	1.731	26.14
	FLAT SLAB WITH DROP	1.812	1.573	15.16

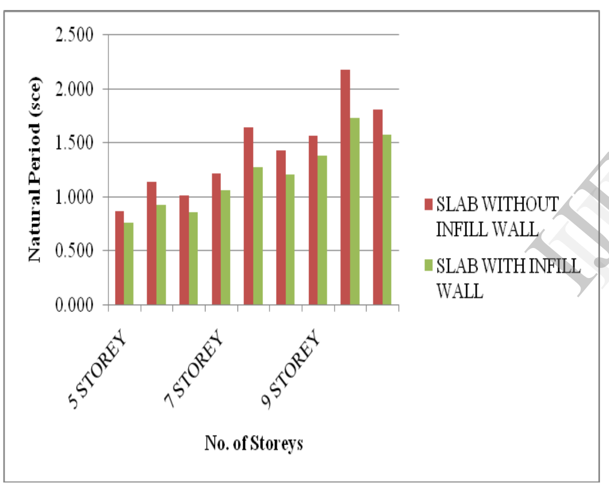

Fig 4.3 Fundamental Natural Period for different type of buildings without and with infill wall.

Table 4.4 Maximum Axial Force for different type of buildings.

	TYPE OF MODEL	SLAB WITHOUT INFILL WALL	SLAB WITH INFILL WALL	% VARIATION
5 STOREY	CONVENTIONALBUILDING	2274.06	2767.21	21.69
	FLAT SLAB WITHOUT DROP	2411.60	2797.92	16.02
	FLAT SLAB WITH DROP	2623.93	2669.15	1.72
7 STOREY	CONVENTIONALBUILDING	3128.41	3676.00	17.50
	FLAT SLAB WITHOUT DROP	3361.54	3939.00	17.18
	FLAT SLAB WITH DROP	3624.22	3754.71	3.60
9 STOREY	CONVENTIONALBUILDING	4012.07	4297.00	7.10
	FLAT SLAB WITHOUT DROP	4256.64	5315.00	24.86
	FLAT SLAB WITH DROP	4529.45	4815.00	6.30

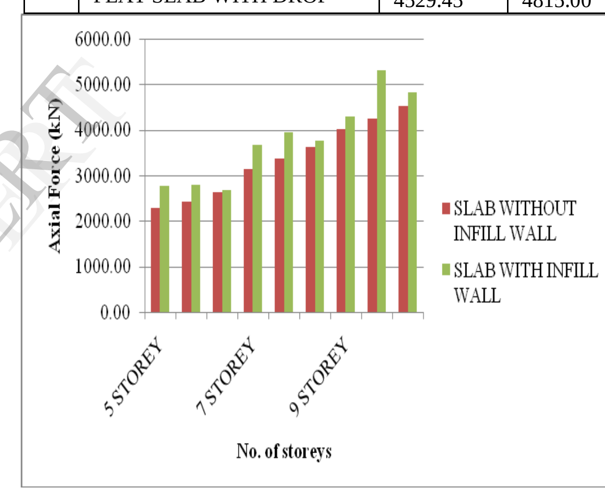

Fig 4.4 Maximum Axial Force for different type of buildings without and with infill wall.

5. Conclusions

1. The Displacement value of Flat slab without Drop buildings is about 63% higher compared Conventional R.C.C building and 19% higher compared to Flat slab with Drop Building.
2. The Fundamental Natural Period increases as the number of stories increases, irrespective of type of building viz. conventional structure. The Fundamental Natural Period value is much higher in Flat Slab without

Drop Buildings Compared to Flat slab with Drop and Conventional R.C.C building.

3. For all the structure, Design base shear increases as the number of stories increases. This increase in design base shear is gradual up to 9th storey, thereafter, it increases significantly gives rise to further investigation on the topic. Design base shear of Conventional R.C.C building is less than the flat slab building.
4. The Axial Force value of Flat slab with Drop is greater than that of Flat Slab without drop and conventional R.C.C building.
5. The Displacement and Fundamental Natural Period value of the buildings with masonry infill wall is lesser compared to without masonry infill wall.
6. The Axial Force and Design Base Shear value of the buildings with masonry infill wall is lesser compared to without masonry infill wall.

6. References

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