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Seismic Analysis of Large Span Commercial Building with the Use of Different Types Slabs for Zone III

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ABSTRACT

Madhya Pradesh State is known as the heart of India. The various city such as Indore, Bhopal, Gwalior, Ujjain etc are now developing with the requirement of structural aspect to live in the city. Ujjain is one of the famous city known as Mahankal temple place etc, so day to day increment of buildings increase with the resources of living things. So it is required to analysis the commercial building concept for the particular place. This article examines the Seismic Analysis of Large Span Commercial Building with the use of different types Slabs for Zone III. In this a 10 storey building is modelled with the various types of types slab are chosen. This slab includes Normal slab, flats slab, waffle & ribbed slab. This project focuses of commercial building project of 10 Storey Building. For the part or partially distribution of area as per the requirement the large span structure taken as 8m. The seimic analysis is carried out for the structure under Zone III with city taken as Ujjain, Madhya Pradesh.

Keywords: Large Span, Normal slab, Flat Slab, Waffle Slabs, Ribbed Slab, Ujjain City, Zone III

1.Introduction

There is a strong demand for quality office space, particularly in urban centres. Head offices of banks and other leading companies require buildings to be constructed to high architectural and environmental standards. The investment “cost” is a key criterion in the choice of a building's architecture, design and service strategy. In most large commercial buildings, the two-stage construction process means that the tenant is responsible for maintenance and equipment, so the building structure must be flexible enough to meet these different requirements. Many small buildings are designed for natural ventilation and are built with many new energy technologies. Many solutions are possible thanks to steel construction. Using new types of slabs in the commercial building for the adoption of different types of slabs. A ribbed slab is made of reinforced concrete with concrete beams extending in mutually perpendicular directions from its base. Due to the grid layout generated by the R.C. the ribs are called waffles. It is also known as a two-way joist slab. It is mainly used when the scope is larger. It is stronger than other types of slab. The slab has two parts. The first part is on the upper side, which is a flat surface, and the second part, on the bottom, consists of beams, creating a grid-like structure. The grid appears when patterns are removed from it. It is also used when heavy loads act on the structure. As a result of stiffness, this type of slab is used where buildings require minimal vibration, such as those used in laboratories, manufacturing facilities. These types of slabs are completely shaped slabs with a series of closely spaced beams which in turn are supported by a set of beams. The main advantage of a ribbed floor is the weight reduction achieved by removing some of the concrete below the neutral axis. This makes this type of flooring economical for spacious buildings with light to moderate loads. Ribbed slabs are basically cast slabs with a series of separate beams which, in turn, are supported by a set of beams. The main advantage of a ribbed floor is the stress reduction achieved by removing some of the concrete below the neutral axis. This makes this type of flooring economical for buildings with large spans and light to moderate loads. A reinforced concrete slab directly supported on concrete columns without the use of beams. These types include various member systems such as drops, column head, edge beam, etc., as well as horizontal slab. Structures of this type use column heads and column struts as replacement plates to provide large column spans. The entire slab rests on the heads of these posts and post rails and acts as a diaphragm. These structures are vulnerable to the dynamic forces of earthquakes, so it is necessary to analyze the dynamic seismic behavior of the structure before designing these structures in earthquake prone areas.

PROBLEM FORMATION AND MODELLING

The structural concert and its formulation are based on the different 5 case in with the use of slabs alongs with the other parameter are tabulated given below.

Table 1: Large Span Structure model cases

S. No.	Case Description	Model Code	Model Description
1	**Case 1**	1LSB-NS	Large Span Building with Normal Slab in MRF
2	**Case 1**	2LSB-RS	Large Span Building with Ribbed Slab
3	**Case 2**	3LSB-WS	Large Span Building with Waffle Slab
4	**Case 4**	4LSB-FSDP	Large Span Building with Flat slab with Drop Panels
5	**Case 5**	5LSB-FSPB	Building having Flat Slab with Drop Panels and Perimeter Beams

Table 2: Basic Structural Details

S. No.	Details of Parameters	Measurement Dimensions
1	Storey levels	10 Storey level
2	Assumed Location	Ujjain City, Madhya Pradesh
3	Height of Structure	35 meter.
4	Basic plan area	2304 square meter
5	Column size	650 mm x 650 mm
6	Plinth beam Dimensions	250 mm x 500 mm
7	Large Spacing Grid C/C	8000 mm

Table 3: Large Span with Waffle Slab & Ribbed Slab

S. No.	Details of Parameters	Measurement Dimensions
1	Beam Size	300 mm x 600 mm
2	Slab Thickness	150 mm
3	Overall Slab thickness	450 mm
4	Stem Width	250 mm
5	Spacing of Stems in X & Y –Direction	2000 mm c/c

Table 4: Large Span with Flat Slab Parameter

S. No.	Details of Parameters	Measurement Dimensions
1	Slab Thickness without Drop	275 mm
2	Slab thickness with Drops	350 mm
3	Drop Size	3.00 m x 3.00 m
4	Thickness of Drops	75 mm
5	Perimeter Beam Size	300 mm x 550 mm

Model Cases 1: 1LSB-NS: Large Span Building with Normal Slab in MRF

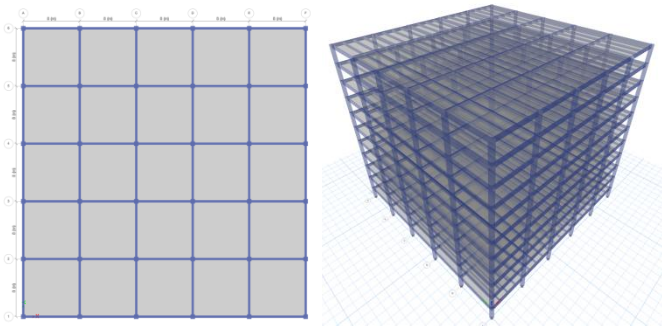


Fig. 1: Case 1LSB-NS a) plan b) 3D view

Model Cases 2: 2LSB-RS: Large Span Building with Ribbed Slab

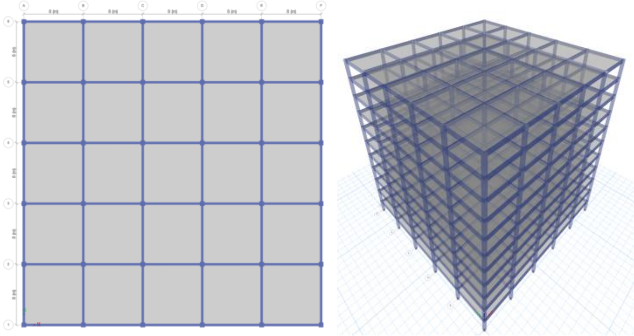


Fig. 2: Case 2 LSB-NS a) plan b) 3D view

Model Cases 3: 3LSB-WS:Large Span Building with Waffle Slab

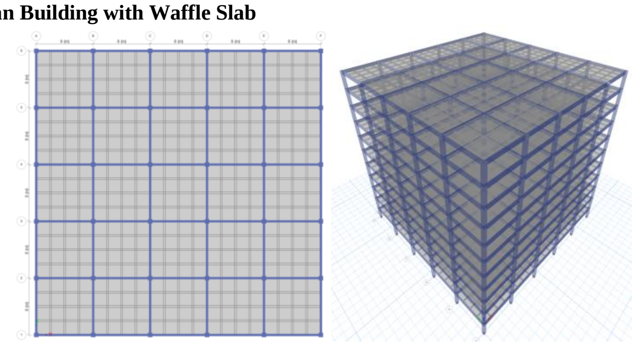


Fig. 3: Case 3 LSB-NS a) plan b) 3D view

Model Cases 4: 4LSB-FSDP:Large Span Building with Flat slab with Drop Panels

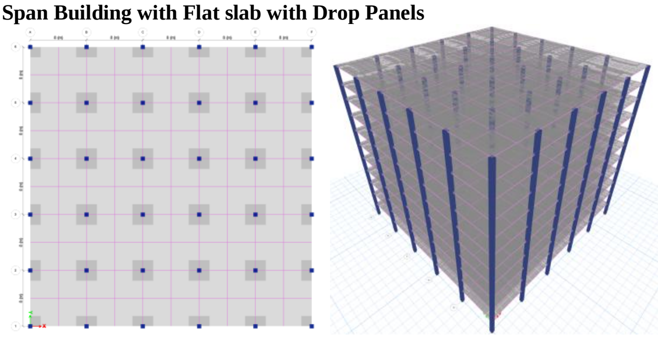


Fig. 4: Case 4 LSB-NS a) plan b) 3D view

Model Cases 5: 5LSB-FSPB: Building having Flat Slab with Drop Panels and Perimeter Beam

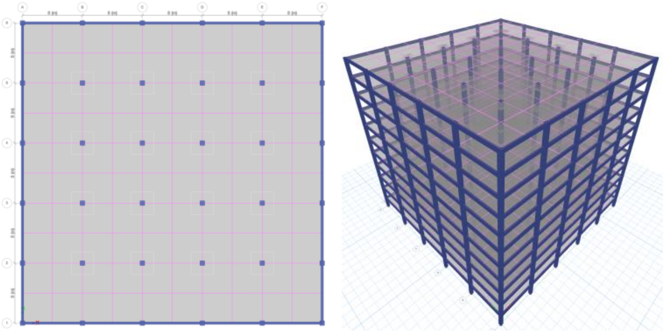


Fig. 5: Case 5 LSB-NS a) plan b) 3D view

Seismic Data: Zone-III, City Consider, Ujjain City, Madhya Pradesh, IF-1.2, Type of Soil Medium (M), Response Reduction Factor-4, Damping Ratio-5%, Earthquake Code 1893-(Part-1)

Material Properties Taken: Concrete M-30, & Rebar HYSD 500

RESULTS PARAMETERS

The following result parameter taken based on modelling and analysis of 10th storey building, which are as follows:

Parameter 1: Maximum Storey Displacement

Table 5 : Maximum Storey Displacement(mm)

S. No.	Model Case	X-Dir.	Z-Dir.
1	**1LSB-NS**	480.34	41.78
2	**2LSB-RS**	463.46	33.17
3	**3LSB-WS**	439.68	35.12
4	**4LSB-FSDP**	492.51	40.2
5	**5LSB-FSPB**	499.59	42.04

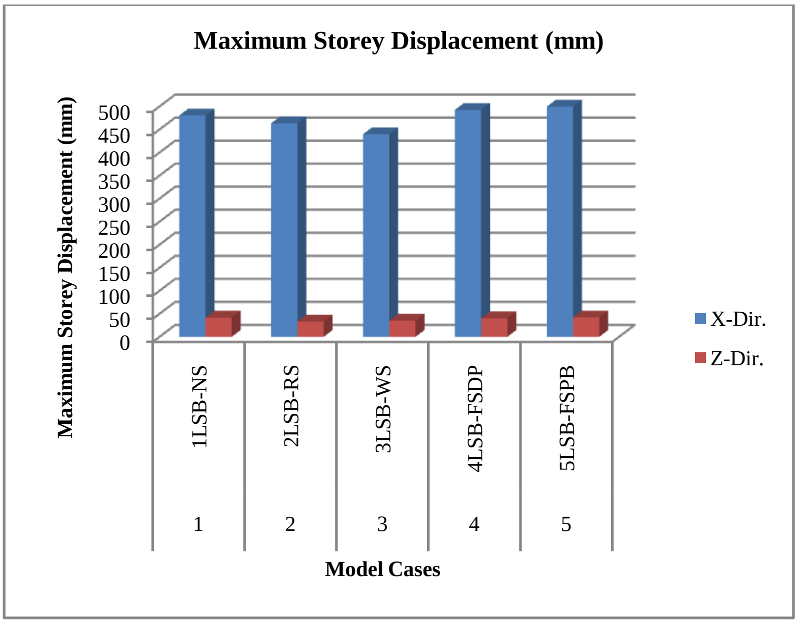


Fig. 6: Max. Storey Displacement for all cases

Parameter 2: Base Shear Result

Table 6: Base Shear (KN)

S. No.	Model	Base Shear
1	**1LSB-NS**	19194.56
2	**2LSB-RS**	19334.67
3	**3LSB-WS**	20633.66
4	**4LSB-FSDP**	20535.84
5	**5LSB-FSPB**	21525.82

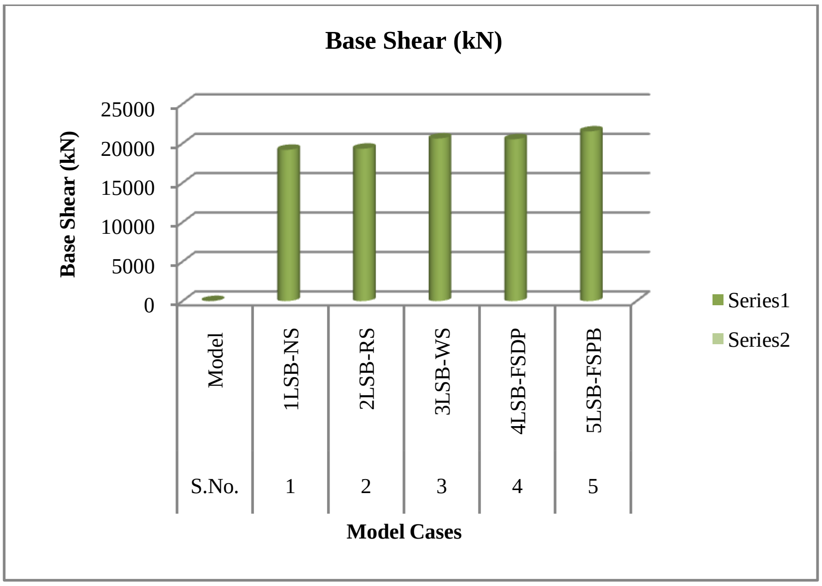


Fig. 7: Base Shear result for all cases

Parameter3: Column Axial Force

Table 7: Column Axial Force

S. No.	Model Case	Column Axial Force (KN)
1	**1LSB-NS**	9399.856
2	**2LSB-RS**	9150.75
3	**3LSB-WS**	9115.934
4	**4LSB-FSDP**	9015.32
5	**5LSB-FSPB**	9088.64

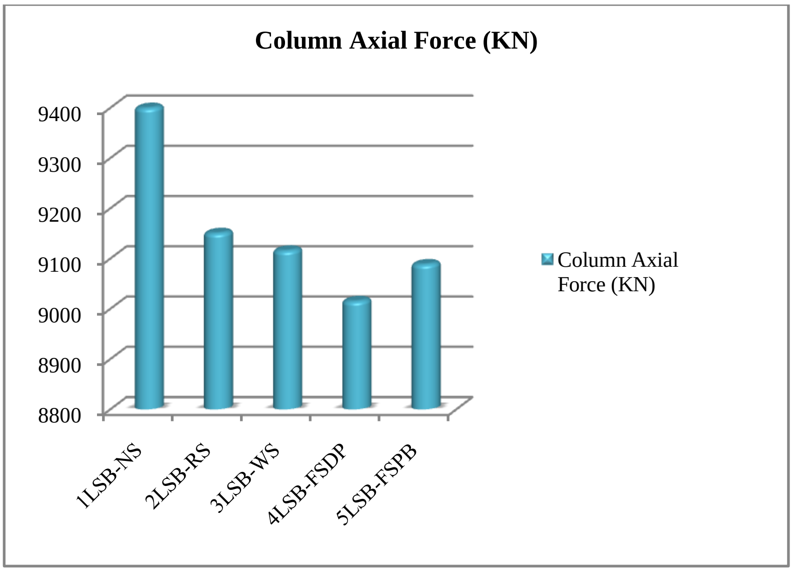


Fig 8 : column axial forces result for all cases

Parameter 4: Bending Moment Result

Table 8: Bending Moment (KN.m)

S. No.	**Model Case**	**X-Dir.**	**Z-Dir.**
1	**1LSB-NS**	748.777	765.02
2	**2LSB-RS**	740.46	744.46
3	**3LSB-WS**	736.797	753.291
4	**4LSB-FSDP**	695.51	705.51
5	**5LSB-FSPB**	704.48	685.36

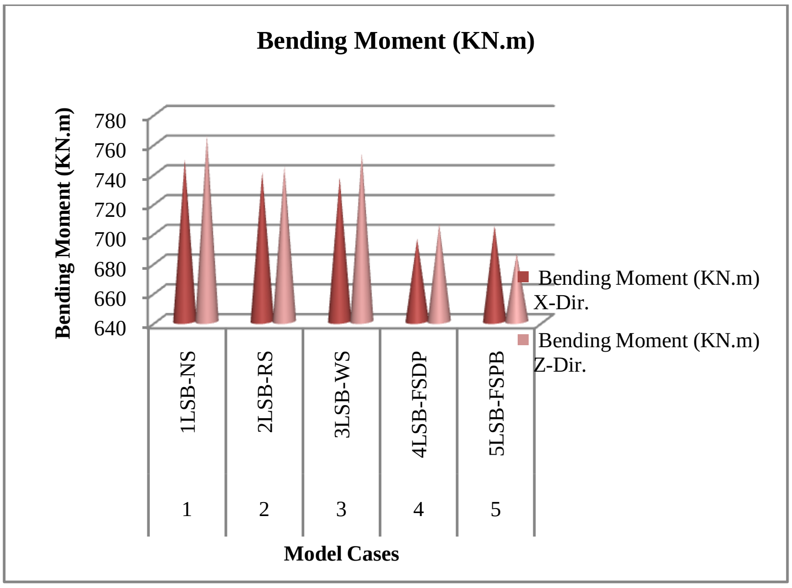


Fig 9: Bending Moment for all cases

Parameter 5: Shear Force Result

Table 9: Shear Force (KN)

S. No.	Model Case	X-Dir.	Z-Dir.
1	**1LSB-NS**	282.84	286.96
2	**2LSB-RS**	283.42	282.86
3	**3LSB-WS**	278.64	280.84
4	**4LSB-FSDP**	280.66	278.85
5	**5LSB-FSPB**	281.45	282.56

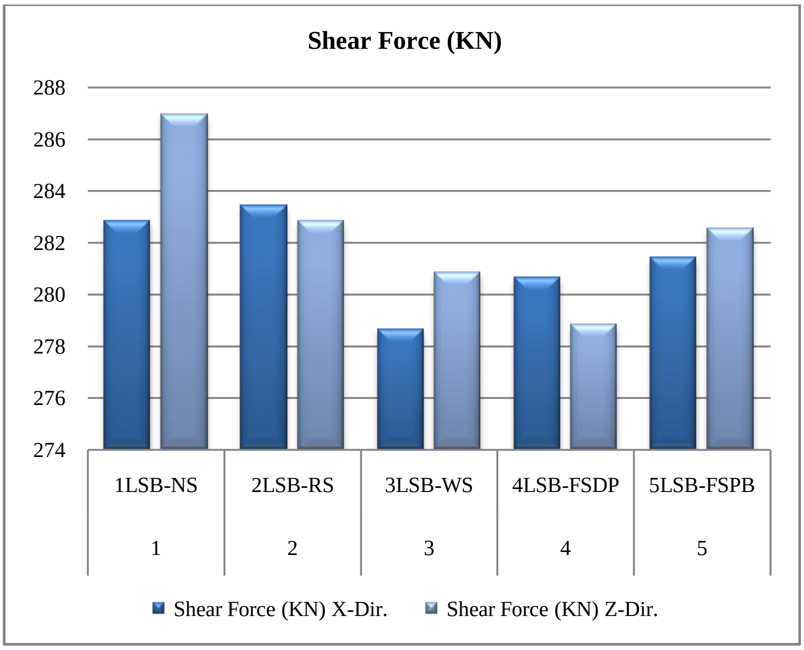
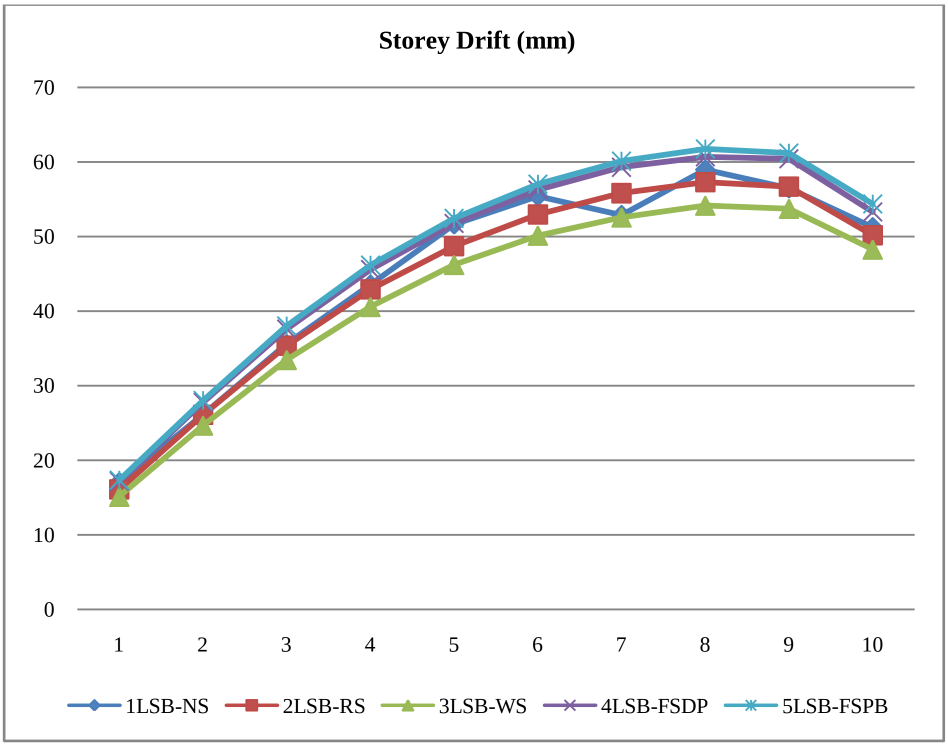


Fig. 10 Shear Force for all cases

Parameter 6: Storey Drift Result

Table 10: Storey Drift (mm)

S. No.	Stories	1LSB-NS	2LSB-RS	3LSB-WS	4LSB-FSDP	5LSB-FSPB
1	**G+9**	17.05	16.08	15.12	17.14	17.32
2	**G+8**	26.11	26.08	24.66	27.73	28.01
3	**G+7**	35.58	35.35	33.45	37.57	38.02
4	**G+6**	43.56	42.9	40.56	45.58	46.16
5	**G+5**	51.63	48.71	46.2	51.76	52.43
6	**G+4**	55.41	52.96	50.12	56.26	57.01
7	**G+3**	52.88	55.81	52.56	59.29	60.1
8	**G+2**	58.96	57.29	54.14	60.68	61.74
9	**G+1**	56.45	56.69	53.72	60.43	61.2
10	**Ground**	51.25	50.17	48.25	53.31	54.37



CONCLUSIONS

- The maximum storey level are obtained are found to be least value in the model case 3 (3LSB-WS), other than this less value obtained in case2 (2LSB-RS) also. The model case 4& 5 get increment in the value due to increment in self weight of the structure.
- Base shear value is defining the increment in the base shear in new types of slab used in the structure (Case 2 to 5) as compare to the normal slab.
- Reduction of axial forces found in the new types of slab. Flat with drop (case 4) & Flat slab with drop & perimeter found the least value. Other slab WS, RS also found reduction in base shear value.
- Reduction of bending moment found in the new types of slab. Case 3 and 2 (3LSB-WS, 2LSB-RS) the least value of bending moment as compare with reference model of normal slab (1LSB-NS).
- Reduction of shear force found in the new types of slab. Case 3 and 4(3LSB-WS, 4LSB-FSDP) the least value of Shear force as compare with reference model of normal slab (1LSB-NS).
- Drift is relative displacement of floor/storey levels. The relative displacement shown the decrement in displacement Case 3 and 2(3LSB-WS, 2LSB-FSDP) the least value as per the curve with reference model of normal slab (1LSB-NS).

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