Seismic Response of Multi-Storied Car Parking Building.

S. S. Kudwe[1], V. U. Mane[2], G. A. Magdum[3],
N. D. Mulani[4], A. D. Nagaonkar[5], S.S.Magdum[6]. Students [1,2,3,4,5], Assistant Professor[6].
CIVIL ENGINEERING DEPARTMENT, S.I.T.C.O.E.YADRAV
sskudwe1701@gmail.com[1], vrushabh251996@gmail.com[2] ,magdum333@gmail.com[3],
naeemdmulani@gmail.com[4], aakshaynagaonkar@gmail.com[5], shantanumagdum1989@gmail.com[6]

Abstract— Multi level car parking system has becomes essential now a days. In order to fulfill this requirement in the limited available land the height of building becomes medium to high-rise. During earthquake, building shows serious damage due to mass irregularity. Vertical Mass irregularity is an important factor which is required to be considered while designing multi-storied building. This paper highlights seismic behavior of multi storied car parking building with three different loading conditions. Structures are analyzed by IS code approach. Response spectrum method of analysis is carried out. Study shows behavioral changes in lateral forces of building due to change in loading condition in earthquake analysis by using software.

Index Terms— Displacement, Earthquake, Load Variation, Muiltistoried Building, Seismic Force, Shear Force, Time Period.

1 Introduction

MULTI level car parking systems has become quite popular in recent times in cities which have become population hubs due to growth of industrial areas, commercial activities etc. as compared to conventional type of parking. Multi level car parking system is just the extension of the conventional surface parking lots in the vertical direction in the particular area. Hence some suitable structural system should be enveloped in order to store large number of vehicles in the particular space. This structural system may be made either of concrete, steel concrete composite or the precast concrete.[2]

Due to lack of land availability in the metropolitan cities the horizontal parking facilities are not enough to serve the society, so it's solution is vertical parking it's called as Multilevel Car Parking.[2] Tall Buildings throughout the world are becoming more popular day by day with the advancement of modern day construction technology and computers, the basic aim now is the construction of safer buildings keeping in view the complete economics of the project. In some areas tall buildings are called "high rise buildings" or even "vertical cities".[1]

Earthquake occurred in multi-storeyed building shows that if the structures are not well designed and constructed with adequate strength it leads to the complete collapse of the structures. To ensure safety against seismic forces of multi-storied building hence, there is need to study of seismic analysis to design earthquake resistance structures. [3]

2 Problem

2.1 Model Genration And Analysis

In this paper a car parking building of G+5 floors is considered. Each floor had a height of 3m. The supports at the base of the structure were also specified as fixed. The structure was subjected to self-weight, dead load, live load, vehicle load values considering by the specifications of IS 875 part-1 .The building is modelled, analyzed and designed with the help of software

Following are the condition for analysis

When all car parked

When no car parked

When car parked only at single floor

2.2 Auto cad Plan of Car Parking Building

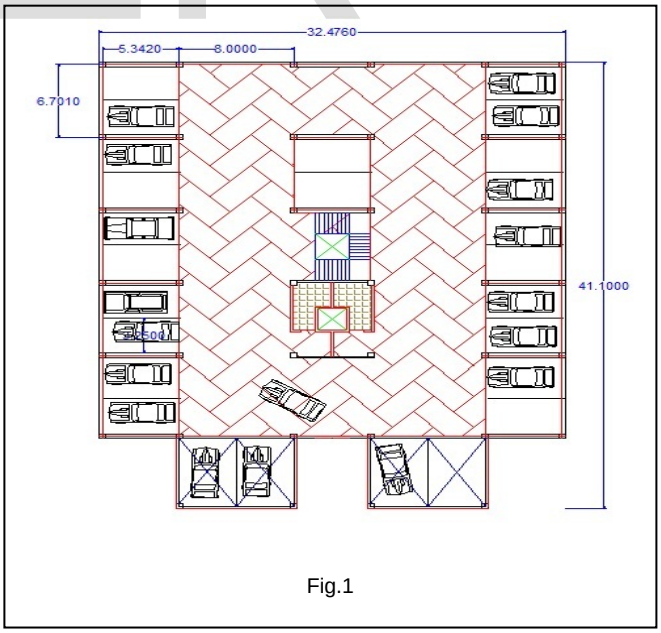


Fig.1

2.3 Modeling Details

- Type of building : Car Parking Structure
- Location of building : Pune region
- Height of building from GL : 18 m
- Typical storey height : 3 m

- Dimensions of building :
  - Length (L) : 32.4m (in X– direction)
  - Breadth (B) : 41.10 m (in Z – direction)
- Material Data
  - Grade of concrete : M 30
  - Yield strength of reinforcement : 500 N/mm2
  - Unit weight of concrete : 25 kN/m^3
- Loading Data
  - Dead Load (DL) :
    - Member load -13.33 kN/m
    - Slab load-6.125 kN/m2
  - Live Load (LL) :
    - Floor Finishes: 0.50 kN/m2
    - Vehicle load-5.5 kN/m2
- Earthquake Load (EL)
    - Zone factor : 0.16
    - Importance factor : 1.5
    - Response reduction factor : 5.0(SMRF

Method of analysis : response spectrum method

3 . Assumption

Following are some assumptions made for general arrangement of building, analysis and design:

- Building is made of reinforced cement concrete
- concrete structure is designed by the limit state method using partial safety factors for loads and material strengths as specified in IS 456:2000
- The model is assumed to have fixed support at base constructed on hard type of soil, located in zone II .

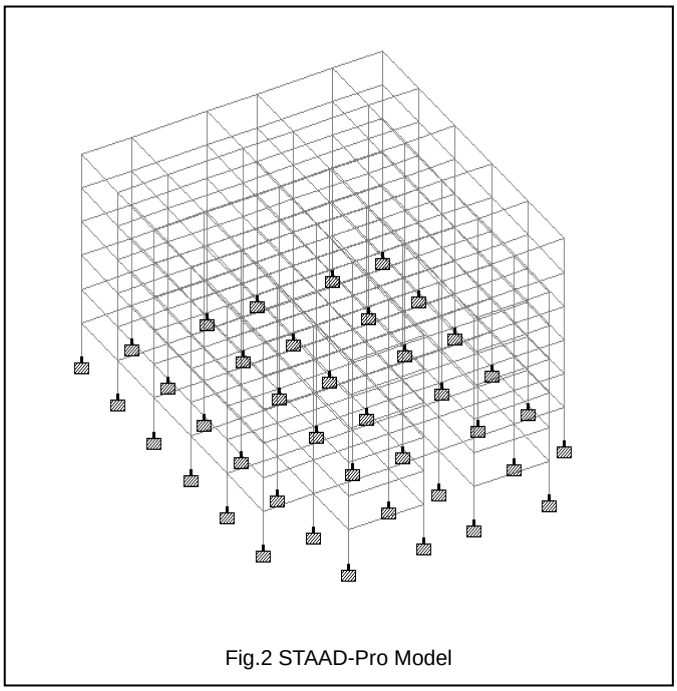


Fig.2 STAAD-Pro Model

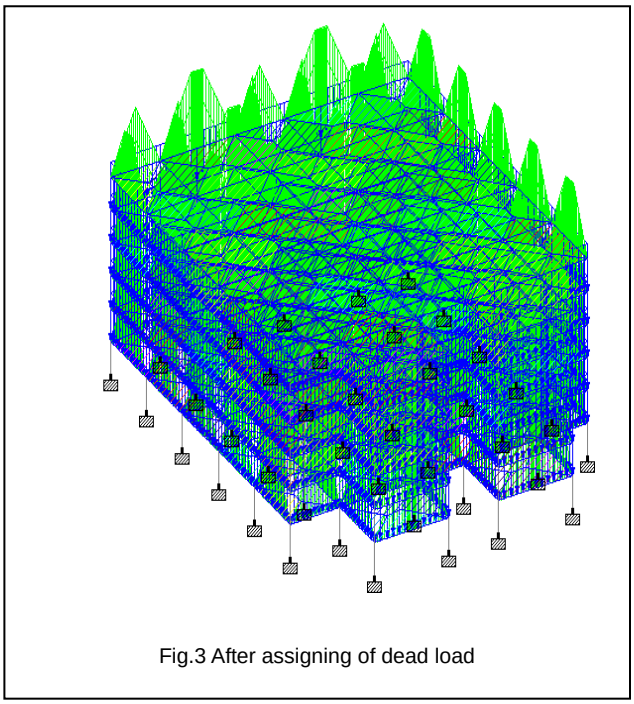


Fig.3 After assigning of dead load

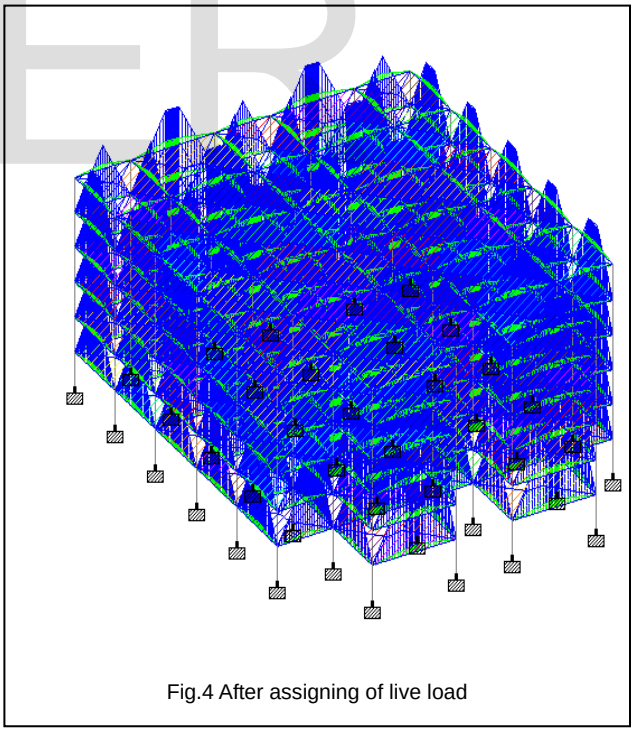


Fig.4 After assigning of live load

4. Results

TABLE 1 NODEL DISPLACEMENT

NO CAR PARKED

	Node	X mm	Y mm	Z mm	mm
		Hoz	Veti	Hoz	Resultant
Max X	243	18.963	0.099	2.633	19.145
Max Y	271	17.031	0.257	13.736	21.882
Max Z	271	17.031	0.257	13.736	21.882
Max rX	41	2.919	0.063	2.462	3.819
Max rY	280	16.918	0.145	11.356	20.376
Max rZ	86	7.351	0.111	5.724	9.317
Max Rst	241	18.962	0.175	13.729	23.411

FULL CAR PARKED

	Node	X mm	Y mm	Z mm	mm
		Hoz	Veti	Hoz	Resultant
Max X	247	19.524	0.26	16.169	25.351
Max Y	247	19.524	0.26	16.169	25.351
Max Z	271	16.168	0.232	16.184	22.877
Max rX	41	2.985	0.062	2.896	4.159
Max rY	277	16.989	0.123	13.415	21.647
Max rZ	92	7.539	0.166	6.736	10.111
Max Rst	247	19.524	0.26	16.169	25.351

TOP FLOOR PARKED

	Node	X mm	Y mm	Z mm	mm
		Hoz	Verti	Hoz	Resultant
Max X	243	19.525	0.102	2.842	19.731
Max Y	247	19.351	0.259	14.629	24.26
Max Z	276	16.927	0.254	14.641	22.382
Max rX	41	2.959	0.064	2.565	3.917
Max rY	277	16.917	0.139	12.107	20.803
Max rZ	86	7.471	0.113	5.986	9.574
Max Rst	246	19.525	0.179	14.63	24.398

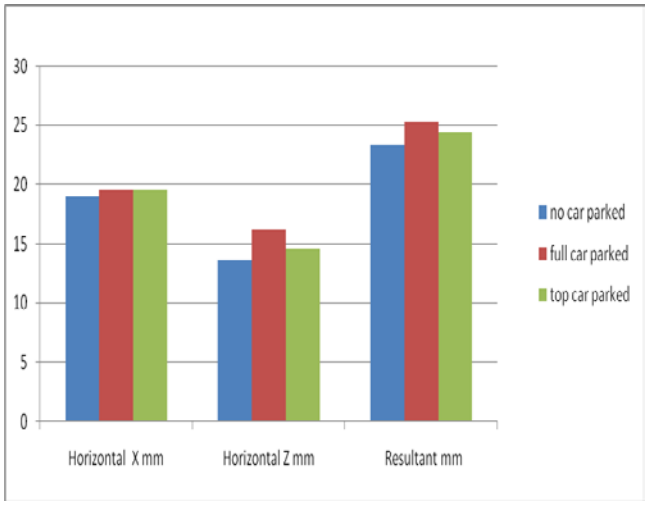


Fig.5 nodel displacement

In above results of nodel dispalcment a fully car parked condition showing maximum displacement than other two condition.

TA TABLE NO 2 STORY SHEAR

SHEAR FOR NO CAR PARKED

Story	Level in meter	Peak story shear in KN
		X
6	18	173.11
5	15	335.55
4	12	474.57
3	9	581.17
2	6	648.78
1	3	675.54
BASE	0	675.45

FULL CAR PARKED

Story	Level in meter	Peak story shear in KN
		X
6	18	203.11
5	15	392.6
4	12	554.79
3	9	679.19
2	6	758.13
1	3	789.42
BASE	0	789.42

TOP FLOOR CAR PARKED

Story	Level in meter	Peak story shear in KN
		X
6	18	155.38
5	15	382.19
4	12	506.44
3	9	600.87
2	6	660.39
1	3	683.86
BASE	0	683.86

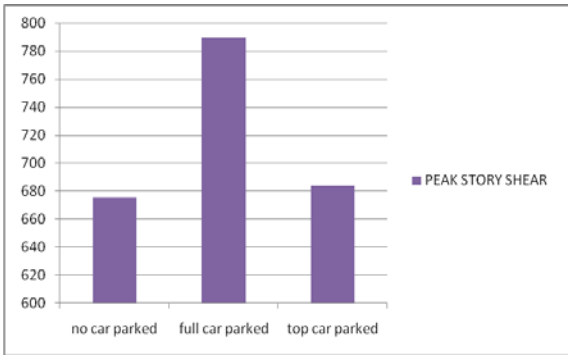


Fig.6 Base shear

In above results of Story shear a fully car parked condition showing maximum shear at the base than other two condition.

TABLE 3 SUPPORT REACTION

REACTION FOR NO CAR PARKED

	Node	Fx kN	Fy kN	Fz kN
		Horizontal	Vertical	Horizontal
Max Fx	2	32.599	69.764	10.733
Max Fy	31	23.219	90.586	12.998
Max Fz	7	25.541	86.699	16.542
Max Mx	7	25.541	86.699	16.542
Max My	40	16.619	49.923	10.934
Max Mz	2	32.599	69.764	10.733

REACTION FOR FULL CAR PARKED

	Node	Fx kN	Fy kN	Fz kN
		Horizontal	Vertical	Horizontal
Max Fx	8	33.346	44.274	16.262
Max Fy	7	26.987	91.713	19.46
Max Fz	25	23.868	76.145	19.461
Max Mx	25	23.868	76.145	19.461
Max My	40	16.886	42.376	12.94
Max Mz	8	33.346	44.274	16.262

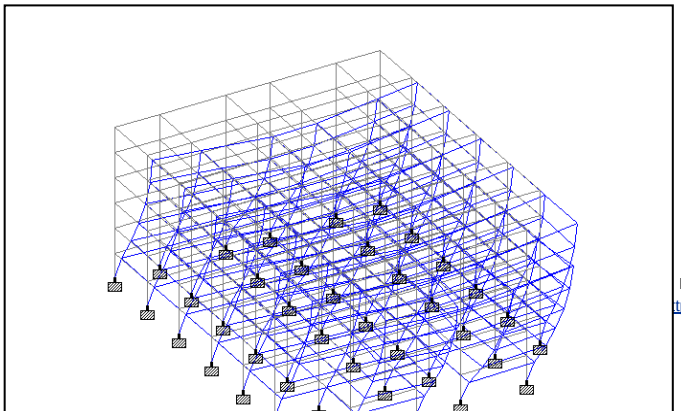
REACTION FOR TOP FLOOR CAR PARKED

	Node	Fx kN	Fy kN	Fz kN
		Horizontal	Vertical	Horizontal
Max Fx	2	32.997	72.77	11.032
Max Fy	7	25.988	90.692	17.219
Max Fz	7	25.988	90.692	17.219
Max Mx	25	23.636	77.096	17.216
Max My	40	16.385	47.921	11.25
Max Mz	2	32.997	72.77	11.032

In above results of reaction a fully car parked condition showing maximum reaction than other two condition.

TABLE 4 TIME PERIOD AND FREQUENCE FOR MODE NO 1

Sr. no.	Condition	Time Period (sec.)	Frequency (cycle/sec.)
1.	No car parked	2.592	0.386
2.	Full CarParked	2.235	0.447
3.	Top Car Parked	2.07	0.481



5 CONCLUSION

1. Displacement of structure increase as mass of structure increases.
2. Base shear of structure increase as mass of structure increases.

REFERENCES

1. **Shubham Bansal, Sangeeta Dhyani** *"Seismic Analysis of a Tall Building with and without Open storey's : A Review"* International Journal of Engineering Research & Technology (IJERT) Vol. 5 Issue 03 (March 2016)

2. **Dr. D. R. Panchal** *"Modelling and Parametric Study of Typical Multi Level Car Parking System"* International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 6. (June 2014)

3. **E.PavanKumar, A.Naresh, M. Nagajyothi, M.Rajasekhar "***Earthquake Analysis of Multi Storied Residential Building - A Case Study"* International Journal of Engineering Research and Applications Vol. 4, Issue 1 **(**November 2014**)**

4. **IS: 1893-2002, Part 1**, "*Criteria for Earthquake Resistant Design of Structures - General Provisions and Buildings*", Bureau of Indian Standards, New Delhi, India.

5. **IS: 456-2000**, "*Code of Practice for Plain and Reinforced Concrete*",Bureau of Indian Standards, New Delhi, India.