COMPARATIVE STUDY OF SEISMIC ANALYSIS OF GROUND STOREY AND PARKING STOREY

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Abstract - *Multistoried buildings with open ground floor are inherently vulnerable to collapse due to earthquake load, their construction is still widespread in the developing nations due to social and functional need for provide car parking space at ground level. Engineering community warned against such buildings from time to time. Along with gravity load structure has to withstand to lateral load which can develop high stresses which leads to destruction of buildings. In this case study R.C.C.plane frame building is modeled and analyzed in two cases. I) Model with no infill wall (Bare Model) with foundation depth=1.5 m. II) Model with no infill wall (Bare Model) with foundation depth=3.5 m (soft storey). Static analysis of the building models is performed in ETABS. The performance of the building is evaluated in terms of top storey displacement, natural period, base shear, shear forces and bending moment in beams, axial forces and bending moment in column. It is found that axial forces and bending moment in corner as well as end column increases in parking storey and increases the top storey displacement in parking building. The results of bare frame, for plinth level frame and open bottom storey frame are discussed and conclusions are made.*

***Key Words*: bare frame, fixed base, natural period, base shear, top storey displacement, axial forces and bending moment in column.**

1. INTRODUCTION

Reinforced concrete (RC) frame buildings are becoming increasingly common in urban India. Reinforced-concrete framed structure in recent time has a special feature i.e. the ground storey is left open for the purpose of parking etc. Such building are often called open ground storey buildings or building on stilts. Open ground storey system is being adopted in many buildings presently due to the advantage of open space to meet the economical and architectural demands. But these stilt floor used in most severely damaged or, collapsed R.C. buildings, introduced 'severe irregularity of sudden change of stiffness' between the ground storey and upper stories since they had infilled bricks walls which increase the lateral stiffness of the frame by a factor of three to four times. In such buildings the dynamic ductility demand during probable earthquake gets concentrated in the soft storey and the upper storey tends to remain elastic. Hence the building is totally collapsed due to soft storey effect.

Construction of multistoried buildings with open first storey is a common practice in India. This is an unavoidable feature and is generally adopted for parking of vehicles or reception lobbies.

A soft storey also known as weak storey. It is a storey in a Building that has substantially less resistance or stiffness than the stories above or below. A soft storey has inadequate shear resistance or inadequate ductility to resist the earthquake induced stresses. Such features are highly undesirable in buildings built in seismically active areas. The soft storey consists of discontinuity of strength stiffness which occurs the second storey connection. Soft storey concept has technical and functional advantages over the conventional construction. Because firstly, the reduction in spectral acceleration and base shear. Due to increase of natural period of the vibration of structure as in base isolated structure. Secondly, soft storey adopted for parking of vehicles and retail shopping, a large space for meeting room or a banking hall.

A simple understanding of soft storey is sudden change of lateral storey stiffness within the structure. An irregularity in vertical configuration tends to create sudden changes in strength or stiffness that may concentrate earthquake forces or other forces in an undesirable way. These can be very difficult to deal with even in a modern structure although the size of the overall force that building must withstand is determined by the Newton's second law of motion, the way in which this is distributed and concentrated, is determined by the configuration of building in horizontal and vertical direction. The overall forces are concentrated at one or few points of the buildings such as a particular set of beams, columns, or walls. These few members may fail and, by chain reaction, bring down the whole building. The most serious condition

of vertical irregularity is that of the soft storey. Such design creates a major stress concentration at that location of discontinuity of lateral storey stiffness and, in Extreme circumstance may lead to collapse unless adequate Design is provided at such locations.
Following images shows view of soft storey (Parking storey) building.

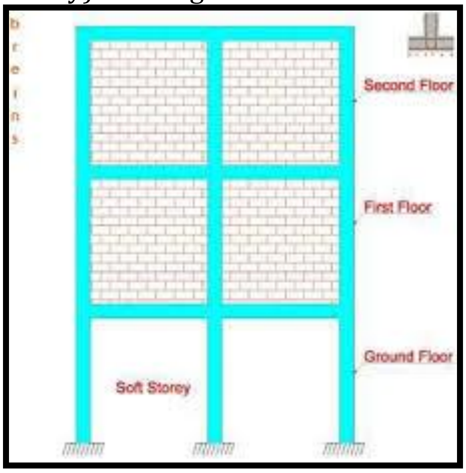

Fig no-1

Fig no-2

1.1 IS Code Provision-
As per IS-1893:2002 (part I) [6]
An Soft Storey is one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys Above.

1.2 Extreme Soft Storey-
An extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storeys above.

1.3 - Types of Failure
There are four major failure types for building structures.

- Soft Storey Failure
- Mass Irregularity failure
- Plan Irregularity Failure
- Shear Failure

2. Parametric Study

A plane frame building model is assumed for seismic analysis that consists of a G+3, G+2 and P+3, P+2 R.C.C. residential building. The plan of the building is regular in nature as it has all columns at equal spacing. The building is located in Seismic Zone V and is founded on hard type soil.

Table -1: Building Features

Structure	SMRF
Floor	G+3,P+3 G+2,P+2
Ground storey height	1.5 m
Parking storey height	3.5 m
Typical storey height	3m
Wall thickness	150 mm
Material	M30
Zone	V
Thickness of slab	150 mm

Table -2: Details of Soft Storey Structures

Type	Soft Storey Floor Height	Foundation Depth
P+3,P+2	3.5 m	1.5 m

Following images shows plan and extrusion view of elevation of plane frame model (soft storey).

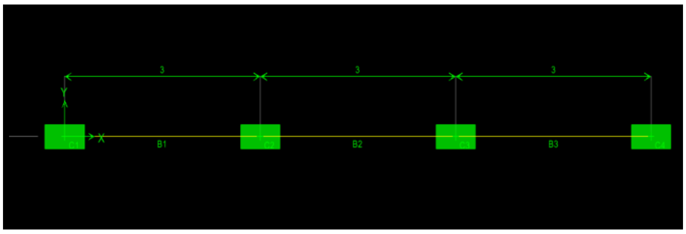

Fig no -3 Plan of Model

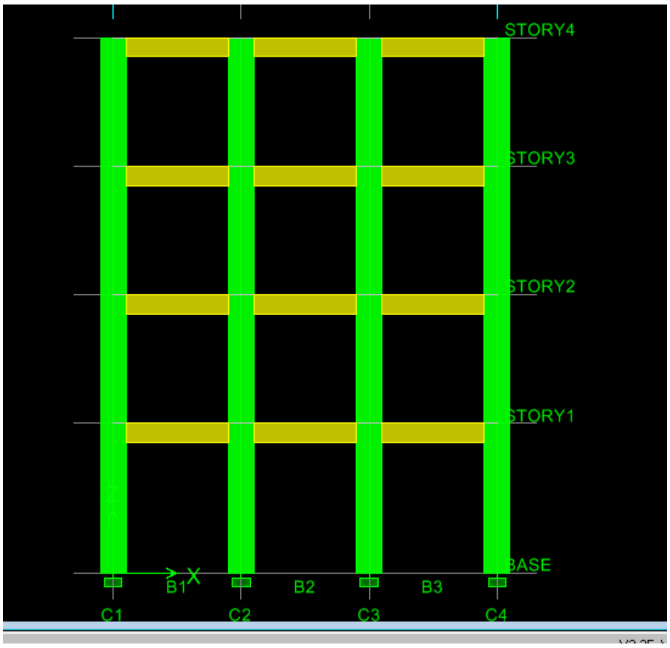

Fig no -4 Open Ground storey

3. COMPARATIVE RESULTS OF GROUND STOREY AND PARKING STOREY FOR VARIOUS PARAMETERS

Table -3 Comparison of results of G+3 and P+3

Parameter		G+2	P+2
Natural Period(sec)		0.2039	0.2767
Base shear(KN)		41.6	64.37
Top storey displacement (mm)		0	2.78
End beam	V_u(KN)	4.6	5.1
	M_u(KNm)	17	20
Centre beam	V_u (KN)	4.8	5.7
	M_u (KNm)	17	20
End column	P_u(KN)	95	99
	M_u (KNm)	3.4	7.1
Centre column	P_u(KN)	164	171
	M_u (KNm)	4.2	8.6

Table -4 Comparison of results of G+3 and P+3

Parameter		G+3	P+3
Natural Period(sec)		0.2963	0.3709
Base shear(KN)		46	82
Top storey displacement (mm)		0	10
End beam	V_u(KN)	4.5	54
	M_u(KNm)	17	69
Centre beam	V_u (KN)	4.8	50
	M_u (KNm)	17	67
End column	P_u(KN)	133	139
	M_u (KNm)	3.5	8.4
Centre column	P_u(KN)	221	228
	M_u (KNm)	5.6	11

4. Conclusions

1) The natural time period is increases for parking frame building as compared to plinth level building.
2) The values of base shear are increases for parking frame building as compared to plinth level building.
3) The values of top storey displacement are increases for parking floor building as compared to plinth level building.
4) The values of top storey displacement are more for P+3 frame than P+2 frame.
5) The values of shear force and bending moment in end beam as well as centre beam are more at parking floor level than ground floor level.
6) The values of axial force and bending moment in end column as well as centre column are more at parking floor level than ground floor level.
7) The values of natural period and base shear are more for P+3 frames than P+2 frames.
8) The values of shear force and bending moment in end beam as well as centre beam are more for P+3 frame than P+2 frame.
9) The values of axial force and bending moment in end column as well as centre column are more P+3 frame than P+2 frame.

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