SEISMIC BEHAVIOR OF R.C.C BARE FRAME UNDER DIFFERENT PARAMETERS

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Abstract - The *recent earthquake has exposed the vulnerability of the existing reinforced concrete building in India. Structural engineer's greatest challenge in today's scenario is constructing seismic resistant structure. This has post a serious threat to the many Indian reinforced concrete buildings which are designed mainly for gravity loads.performance based seismic engineering is the modern approach to earthquake resistant design. It is limit-state design extended to cover complex range of issues faced by earthquake engineers. Three new R.C.C buildings were taken for analyais: G+3, G+5, G+7, to cover broader specturum of low rise and high rise building construction. Bare frame modeling isssuse were incorporated through one model of G+3, G+5, G+7, buildings were. All three condition for 1-8 bays. The present study attempts to investigate the variation between different parameters like natural period and base shear for different type of bays, span of beams and for different stories. As per the Bureau of Indian Standard (BIS) 1893:2002 (Part I) provisions, seismic zones are considered. To response parameters like Natural period, base shear, under seismic force under the static analysis is studied. This analysis focuses on the base shear carrying capacity of structure under severe zones of India. The analysis is done only for medium soil. The soft computing tool and commercial software ETAB is used for modeling and analysis.*

Key Words: *Reinforced concrete bare frame, natural period, base shear, storey displacement.*

1. INTRODUCTION

The masonry buildings have proved to be the most vulnerable to earthquake forces and have suffered maximum damage in past earthquakes. A survey of the affected areas in past earthquakes (Bhuj, 2001, Chamoli, 1999, Jabalpur, 1997, Killari, 1993, uttarkashi, 1991, and Bihar- Nepal, 1998,) has clearly demonstrated that the major loss of lives was due to collapse of low strength masonry buildings.

The loss of lives could have been minimized up to optimum by making the buildings earthquake resistant. Each earthquake puts buildings in the affected area to an earthquake withstand test and provides an opportunity to learn lessons for future preparedness to meet the challenge of disaster. Thus, the efforts of post-earthquake damage survey should be directed to arrive at engineering lessons for improving earthquake resistant design and construction practice.

Bare Frame: - The in-plane stiffness of masonry infill wall is not taken into account in bare frame. Bare frame will deflect under horizontal loads by bending in columns and beams .Non-structural components such as masonry that are subjected to seismic forces are not normally within the design scope of the structural engineer, whose responsibility is to provide the seismic safety of the building.

2. Theoretical Formulation

2.1 Objective

The main objective of this work is to carry out the effect of bays, different span of beam, on the seismic behavior of R.C.C. plane frame with linear static analysis method.

In the analysis work of bare frame models of R.C.C. plane frame G+3, G+5, G+7 floors are made to know the realistic behavior of building during earthquake.

2.2 Seismic Methods of Analysis

Once the structural model has been selected it is possible to perform analysis to determine the seismically induced forces in the structures there are different methods of analysis which provide different degrees of accuracy. The analysis process can be categorized on the basis of three factors; the type of the externally applied loads, the behaviors of structure/or structural materials, and the type of structural model selected (Figure: 1) based on the type of external action and behavior of structure, the analysis can be further classified as linear static analysis, linear dynamic analysis, nonlinear static analysis, or non-linear dynamic analysis.

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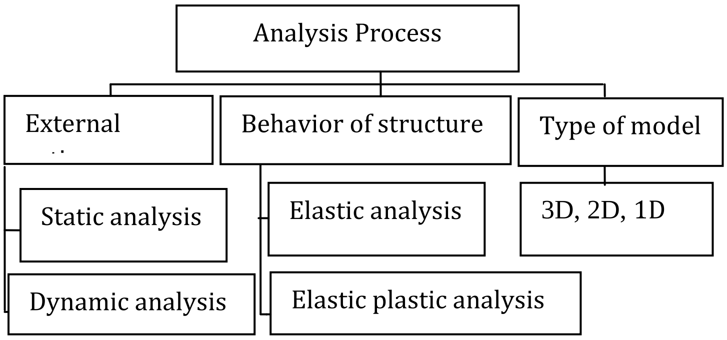

Figure: 1 Method of Analysis Process.

2.2.1Linear static analysis

Equivalent static analysis is the indirect method of considering the effect of ground motion and there is incorporation of dynamic properties of the structure in terms of fundamental period, response reduction factor, soil type, seismic zone and importance factor. Equivalent static analysis were carried out for all the models under the action of Dead load (DL), Live load (LL) and earthquake load (EQ) for different load combination as per IS 1893-2002. This method is limited to regular type of structure whose response is governed by first mode of vibration. As per IS 1893-2002 regular structure up to 40m in height in zone IV and V and up to 90m in zone II and III can be analyzed.

Fundamental Natural Period

The elastic properties and mass of building causes to develop a vibratory motion when they are subjected to dynamic action.This vibration is similar to vibration of a violin string, which consists of a fundamental tone and the additional contribution of various harmonics. The vibration of a building likewise consists of a fundamental mode of vibration and the additional contribution of various modes, which vibrates at higher frequencies. In low-rise building (say less than five-story high) the seismic response depends primarily on the fundamental mode of vibration; accordingly, the period of vibration of this mode, expressed in seconds, is one of the most representative characteristics of the dynamic response of a building. On the basis of time period, building may be classified as rigid (T<0.3sec), semi-rigid (0.3sec<T<1.0sec) and flexible structure (T<1.0sec). Buildings with higher natural frequencies, and a short natural period, tend to suffer higher accelerations but smaller displacement. In the case of buildings with lower natural frequencies, and a long natural period, this is reversed: the buildings will experience lower accelerations but larger displacements. Fundamental period of vibration can be determined by the code based empirical formulas and fundamental modes of the buildings may be determined by an one of the several methods developed for the dynamic analysis of structures.

Base Shear

Seismic analyses of most of the structures are still carried out on the basis of lateral force assumed to be equivalent to the actual (dynamic) loading. The base shear which is the total horizontal force on the structure is calculated on the basis of structure mass and fundamental period of vibration and corresponding mode shape.

2.2.2 SMRF (Special Moment-Resisting Frame)

It is a moment resisting frame specially detailed to provide ductile behavior and comply with the requirements given in IS 4326 or IS 13920 or SP6.For the analysis and design purpose one model has been considered namely as bare frame (S.M.R.F frame).

3. STRUCTURAL DETAIL

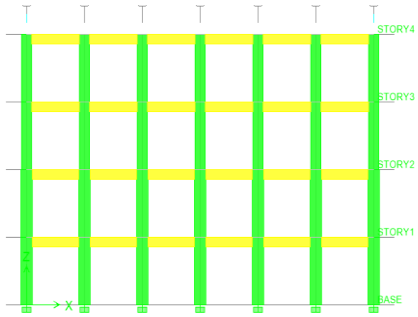

Fig 3: View of G+3 frame

3.1 Load Consideration

Loads acting on the structure are dead load (DL), Live Load (IL) and Earthquake Load (EL)

DL: Self weight of the structure, Floor load and Wall loads

Self-weight of slab= 0.15x25=3.75 KN/m

Floor load =1.25 KN/m

Wall load= (3-0.45) x0.15x20=7.65 KN/m

LL=4KN/m^2

LL=4X1=4 KN/m

3.2 Structural details

RCC Frame Details	
Grade of Concrete	25N/mm^2
Grade of steel	415N/mm^2
Modulus of Elasticity of Concrete	25000000N/mm^2
Modulus of elasticity of steel	200000N/mm^2
Unit Weight of Concrete	25KN/m^3
Poisson's Ratio for concrete	0.2
Size of Beam	230mmx450mm
Support condition	Fixed
Sizes of Column	300mmx600mm
	300mmx550mm
	300mmx500mm
Span of Beam	3m,3.2m,3.4m,3.6m,3.8m,4 m
Type of Building	G+3, G+5, G+7.
Floor height	3 m
Slab thickness	150 mm
Type of Soil	Medium
Seismic Zone	IV,V
Thickness of wall	150mm

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4. RESULT AND DISCUSSION

The results of G+3, G+5 and G+7 bare frame models has presented in this section. Following tables are representing the values of natural period and base shear for One to Eight bays.

Table- 1: Natural Period (Sec) & Base shear (KN) for One to Four bays for (G+3)

Span	Zone	1 Bay		2Bay		3Bay		4Bay	
		Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)
3m	IV	0.3766	22.49	0.3816	42.29	0.3840	61.91	0.3853	81.88
	V	0.3766	33.74	0.3816	63.43	0.3840	93.12	0.3853	122.8
3.2m	IV	0.3972	24.38	0.4044	46.05	0.4076	67.73	0.4093	89.40
	V	0.3972	36.56	0.4044	69.08	0.4076	101.5	0.4093	134.1
3.4m	IV	0.4185	26.34	0.4278	49.84	0.4317	73.62	0.4339	97.25
	V	0.4185	39.29	0.4278	74.97	0.4317	109.2	0.4339	145.8
3.6m	IV	0.4405	28.40	0.4518	54.11	0.4565	79.81	0.4590	105.5
	V	0.4405	42.48	0.4518	81.16	0.4565	119.7	0.4590	158.2
3.8m	IV	0.4631	30.46	0.4763	58.41	0.4817	86.26	0.4846	114.1
	V	0.4631	45.83	0.4763	87.61	0.4817	129.0	0.4846	170.7
4m	IV	0.4862	32.61	0.5013	62.88	0.5073	92.97	0.5106	122.7
	V	0.4862	49.18	0.5013	94.32	0.5073	139.4	0.5106	184.5

Table- 2: Natural Period (Sec) & Base shear (KN) for Five to Eight bays for (G+3)

Span	Zone	5Bay		6Bay		7Bay		8Bay	
		Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)
3m	IV	0.3862	101.67	0.3868	121.46	0.3872	141.26	0.3875	161.05
	V	0.3862	152.08	0.3868	181.70	0.3872	211.31	0.3875	241.58
3.2m	IV	0.4105	111.78	0.4112	131.66	0.4118	154.43	0.4122	175.62
	V	0.4105	166.62	0.4112	199.13	0.4118	213.01	0.4122	264.15
3.4m	IV	0.4352	120.89	0.4361	144.53	0.4368	168.17	0.4374	191.29
	V	0.4352	181.34	0.4361	216.80	0.4368	251.56	0.4374	287.71
3.6m	IV	0.4606	130.86	0.4617	156.49	0.4625	182.12	0.4631	208.33
	V	0.4606	196.82	0.4617	235.38	0.4625	273.18	0.4631	312.49
3.8m	IV	0.4864	143.20	0.4877	169.82	0.4886	197.68	0.4893	225.53
	V	0.4864	212.95	0.4877	254.73	0.4886	294.91	0.4893	338.30
4m	IV	0.5127	153.15	0.5141	183.24	0.5151	212.17	0.5159	242.75
	V	0.5127	229.72	0.5141	274.85	0.5151	318.25	0.5159	363.14

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Table- 3: Natural Period (Sec) & Base shear (KN) for One to Four bays for (G+5)

Span	Zone	1 Bay		2Bay		3Bay		4Bay	
		Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)
3m	IV	0.6128	29.91	0.6035	57.09	0.6012	84.33	0.6002	111.15
	V	0.6128	44.96	0.6035	85.65	0.6012	126.50	0.6002	166.73
3.2m	IV	0.6434	30.86	0.6384	58.90	0.6376	86.73	0.6374	114.52
	V	0.6434	46.30	0.6384	87.96	0.6376	130.10	0.6374	171.78
3.4m	IV	0.6755	31.70	0.6744	60.51	0.6750	88.65	0.6756	117.55
	V	0.6755	47.75	0.6744	90.76	0.6750	133.28	0.6756	176.32
3.6m	IV	0.7091	32.70	0.7117	62.07	0.7136	91.32	0.7148	120.53
	V	0.7091	49.06	0.7117	93.11	0.7136	136.97	0.7148	180.79
3.8m	IV	0.7439	33.38	0.7499	63.59	0.7530	93.12	0.8624	106.52
	V	0.7439	50.30	0.7499	95.17	0.7530	140.29	0.8624	159.78
4m	IV	0.7797	34.33	0.7890	65.06	0.7932	95.26	0.7956	126.28
	V	0.7797	51.31	0.7890	97.38	0.7932	142.89	0.7956	189.42

Table- 4: Natural Period (Sec) & Base shear (KN) for Five to Eight bays for (G+5)

Span	Zone	5Bay		6Bay		7Bay		8Bay	
		Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)
3m	IV	0.5997	138.14	0.5994	165.47	0.5992	192.50	0.5991	
	V	0.5997	138.44	0.5994	248.21	0.5992	288.75	0.5991	329.29
3.2m	IV	0.6374	141.99	0.6374	170.01	0.6374	197.83	0.6402	219.53
	V	0.6374	212.99	0.6374	253.99	0.6374	296.11	0.6402	338.87
3.4m	IV	0.6884	148.79	0.6762	174.52	0.6764	203.00	0.6766	231.48
	V	0.6884	222.70	0.6762	261.21	0.6764	304.50	0.6766	347.22
3.6m	IV	0.7179	149.56	0.7161	178.93	0.7165	207.21	0.7084	240.42
	V	0.7179	224.35	0.7161	268.39	0.7165	312.18	0.7084	361.41
3.8m	IV	0.7590	155.00	0.7567	183.23	0.7573	212.68	0.7577	243.00
	V	0.7590	233.02	0.7567	274.84	0.7573	319.67	0.7577	364.30
4m	IV	0.7971	156.86	0.7981	187.44	0.7989	218.01	0.7994	247.50
	V	0.7971	235.29	0.7981	281.16	0.7989	325.60	0.7994	372.87

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Table- 5: Natural Period (Sec) & Base shear (KN) for One to Four bays for (G+7)

Span	Zone	1 Bay		2Bay		3Bay		4Bay	
		Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)
3m	IV	0.8809	27.73	0.8411	54.33	0.8311	81.36	0.8232	107.76
	V	0.8809	41.37	0.8411	81.73	0.8311	122.05	0.8232	160.76
3.2m	IV	0.9190	28.72	0.8867	56.26	0.8796	83.60	0.8730	110.97
	V	0.9190	43.19	0.8867	84.39	0.8796	125.06	0.8730	166.39
3.4m	IV	0.9600	29.80	0.9344	57.96	0.9299	86.22	0.9244	113.69
	V	0.9600	44.81	0.9344	86.94	0.9299	128.62	0.9244	170.53
3.6m	IV	1.0035	30.56	0.9840	59.59	0.9793	88.31	0.9773	116.67
	V	1.0035	46.23	0.9840	89.38	0.9793	132.11	0.9773	175.01
3.8m	IV	1.0464	31.55	1.0367	61.06	1.0348	90.74	1.0330	120.06
	V	1.0464	47.46	1.0367	91.85	1.0348	135.74	1.0330	180.09
4m	IV	1.0962	32.47	1.0876	62.65	1.0894	92.91	1.0867	122.36
	V	1.0962	48.70	1.0876	93.97	1.0894	138.98	1.0867	184.05

Table- 6: Natural Period (Sec) & Base shear (KN) for Five to Eight bays for (G+7)

Span	Zone	5Bay		6Bay		7Bay		8Bay	
		Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)	Natural period (Sec)	Base shear (KN)
3m	IV	0.8223	134.68	0.8180	160.44	0.8188	187.92	0.8155	213.97
	V	0.8223	201.47	0.8180	241.33	0.8188	281.89	0.8155	320.95
3.2m	IV	0.8729	138.55	0.8690	165.46	0.8702	193.21	0.8671	219.96
	V	0.8729	207.83	0.8690	247.51	0.8702	289.02	0.8671	329.94
3.4m	IV	0.9250	142.33	0.9216	169.93	0.9232	198.38	0.9202	225.22
	V	0.9250	213.49	0.9216	254.90	0.9232	297.57	0.9202	338.75
3.6m	IV	0.9787	146.00	0.9755	174.30	0.9775	203.44	0.9747	231.59
	V	0.9787	219.01	0.9755	261.45	0.9775	303.50	0.9747	347.38
3.8m	IV	1.0333	149.56	1.0322	178.32	1.0328	207.21	1.0319	236.88
	V	1.0333	223.73	1.0322	267.48	1.0328	312.51	1.0319	354.36
4m	IV	1.0893	153.05	1.0583	189.87	1.0895	213.16	1.0896	243.21
	V	1.0893	228.95	1.0583	284.80	1.0895	319.74	1.0896	363.83

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5. CONCLUSIONS

1) Seismic anyalysis of bare frame shows that the values of natural period and base shear increases as number of bays, span of beam and building height increases.
2) The value of base shear is more for seismic zone V as compare to seismic zone IV.
3) The value of top storey displacements goes on increasing as height of building changes.
4) Lateral loads affect not only natural period, base shear but it also affects lateral deflection therefore lateral load and gravity load should be considerd.

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