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Study of Base Shear, Storey Shear and Base Moment on Multistory Building for Different Seismic Zones

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Abstract:
This paper highlights study of variation in base shear, storey shear and base moment for different seismic zones. In present study an earthquake load is applied on G+3, G+5, G+7, G+9 storey buildings for two different plan areas and different seismic zones. The performance of building for base shear, storey shear and base moment has been studied. This analysis is done by using STAAD-Pro v8i software and referring to the code IS 1893:2002(Part-I)

Keywords: Base shear, Storey shear, Base moment, STAAD-Pro v8i.

I. INTRODUCTION

Over the past few years, India's infrastructure system has grown up tremendously at the same time lots of research has been done in the field of construction. With prime importance of comfort and economy safety also plays major role in the design of any structure. Now a day's earthquake resistant design got main attention in design of any type of structure. Earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Base shear, storey shear and base moment are the terms associated with the earthquake. Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. It depends upon thesoil conditions at the site. Storey shear factor is the ratio of the story shear force when story collapse occurs to the story shear force when total collapse occurs. Through a series of dynamic analyses, simple equations are provisionally proposed to calculate the necessary story shear safety factor that can be used to prevent story collapse. Base moment is the moment produced at the base of structure due to different loading conditions on the structure. Present study focuses on the behaviour of base shear, storey shear and base moment with respect to change in number of storey and with change in seismic zone.

II .LITERATURE REVIEW

Mohd Zain Kangda, Manohar D. Mehare, Vipul R. Meshram."Study of base shear and storey drift by dynamic analysis."International Journal of Engineering and Innovative Technology (IJEIT) Volume 4, Issue 8, February 2015.
In the present paper, effect of height of building on base shear, lateral forces and storey drift is evaluated by using STAAD software and the results are compared with IS1893 (Part1:2002). For these purpose seismic coefficient method (SCM) specified in IS1893 (Part1:2002) is taken into consideration and results are obtained in STAAD by SCM.

Hardik Desai, Tahabookseller, Pratha Vyas "Base Shear Calculation of RCC Structure"International Conference on "Recent Research Development in Science, Engineering and Management" ISBN: 978-81-931039-0-6,
This paper deals with the comparison of base shear of G+3 RCC structure. The comparison of static base shear for a structure with masonry and without masonry in different seismic zones is carried out.

GiruMindaye, Dr.ShaikYajdani, "Seismic Analysis of a Multistorey RC Frame Building in Different Seismic Zones", International Journal of Innovative Research in Science, Engineering and Technology. Vol. 5, Issue 9 September 2016.
This paper focus on seismic response of a residential G+10 RC frame building.These analysis are carried out by considering different seismic zones, medium soil type for all zones and for zone II & III using OMRF frame type and for those of the rest zones using OMRF & SMRF frame types. Different response like lateral force, overturning moment, story drift, displacements, base shear are plotted in order to compare the results of the static and dynamic analysis.

Bhattacharya S.P, Chakraborty S.K,"Estimation of storey shear of a building with Mass and Stiffness variation due to Seismic excitation", International Journal Of Civil And Structural Engineering Volume 1, No 3, 2010 This paper attempted to investigate the proportional distribution of lateral forces evolved through seismic action in each storey level due to changes in mass and stiffness of building. As per the BIS provisions, a multi-storey symmetrical building is considered as simplified lump mass model for the analysis with various mass and stiffness ratios. The sway pattern of multi-storeyed building under seismic excitation is taken under consideration with parabolic shape functions. The result concludes as a building structure with high mass and stiffness ratio provides instability and attracts huge storey shear. A proportionate amount of mass and stiffness distribution is advantageous to control over the storey and base shear.

IV. METHODOLOGY

In this we have considered two plan areas (9m*12m and 12m*15m) for different storey height and for different earthquake zones. The loading is done with referring to the code IS 1893:2002(Part-I).The modelling and analysis is done using STAAD-Pro v8i software for G+3,G+5,G+7,G+9 storey models for zone II, zone III, zone IV and zone V .

Table.1. Descriptions of Building Model

Sr.No.	Building Parameters	Description
1	Type of Frame	SMRF
2	Seismic Zone	All [As per IS 1893 (Part 1):2002]
3	Importance Factor (I)	1
4	Response Reduction Factor	5
5	Type of Soil	Medium (Type II)
6	Damping of Structure	5%
7	Loadings	
	i) Dead Load	Self-weight of structural elements
	ii) Floor Finishes	1 KN/m^2
	iii) Live Load	3 KN/m^2
8	Storey, 3bays in X and Z Direction	Four (G+3) / Eight (G+7) Six (G+5) / Ten (G+9)
9	i) Open Ground Storey Height	3 m
10	ii) Upper Stories Height	3m (Each)
11	Grade of Concrete	M25
12	Grade of Steel (MPa)	Main Steel - Fe 500 / Secondary Steel -415
13	Specific Weight of RCC	25kN/m^3
14	Seismic Load Combination	As per IS 1893 (Part 1):2002 a. 1.5(DL + LL) c.1.2(DL+LL±EQ) b. 1.5(DL±EQ)
15	Size of Beam	230 x 450 mm
16	Column Sizes	400 x 400 mm
17	Thickness of Slab	150 mm
18	Thickness Brick Wall	230 mm
19	Grade of Concrete	M25
20	Grade of Reinforcement	Fe 500
21	Density of Concrete	25 KN/m^3
22	Density of Brick Masonry	20 KN/m^3
24	Depth of slab	150 mm
25	Poisson Ratio of Brick Masonry	0.15
26	Modulus of Elasticity of Concrete	25000 KN/m^2

V. PLAN AREA

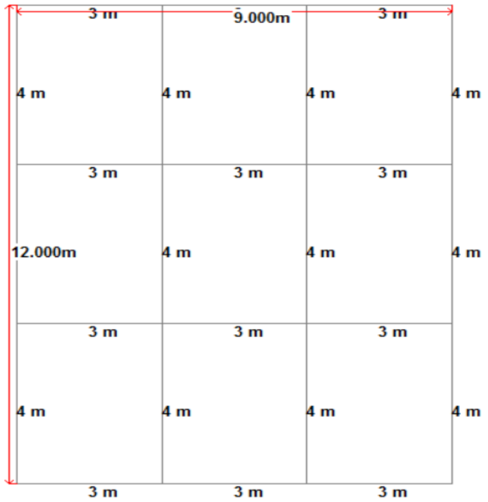

Figure.1. Plan areas of 9mx 12m(M-I)

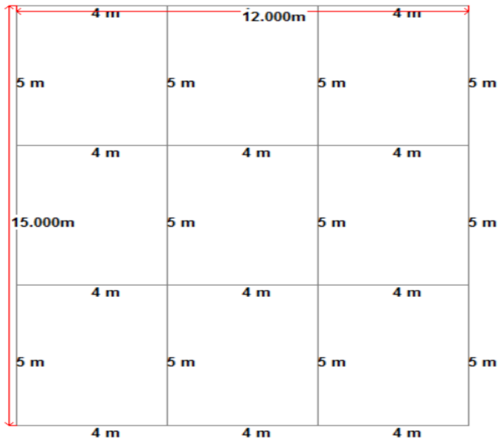

Figure.2.Plan areas of 12mx 15m(M-II)

VI.TEST RESULT AND DISCUSSION

Table 2.Base Shear (KN) comparison for M-I

Plan area	9mx 12m(M-I)			
Zone / Floor	**G+3**	**G+5**	**G+7**	**G+9**
II	207.18	257.94	277.18	293.078
III	331.49	412.71	443.48	468.93
IV	404.64	619.06	665.23	703.39
V	745.85	928.59	997.84	1055.08

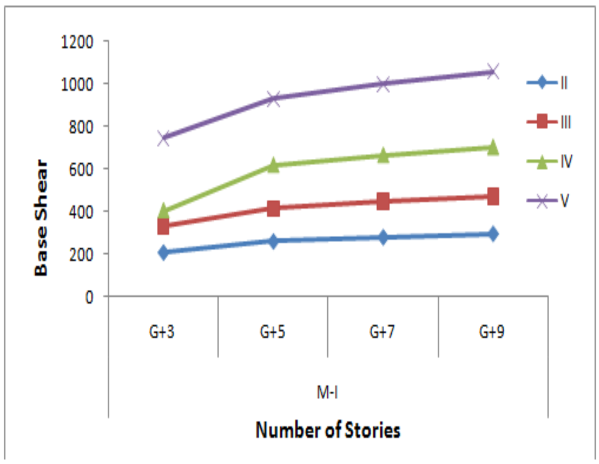

Figure.3.Base Shear variation for M-I

Table.3. Base Shear (KN) comparison for M-II

Plan area	12mx 15m(M-II)			
Zone / Floor	**G+3**	**G+5**	**G+7**	**G+9**
II	283.83	353.38	379.73	401.51
III	454.13	565.4	607.56	642.42
IV	681.2	848.1	911.34	963.63
V	845.24	1272.15	1367.01	1445.45

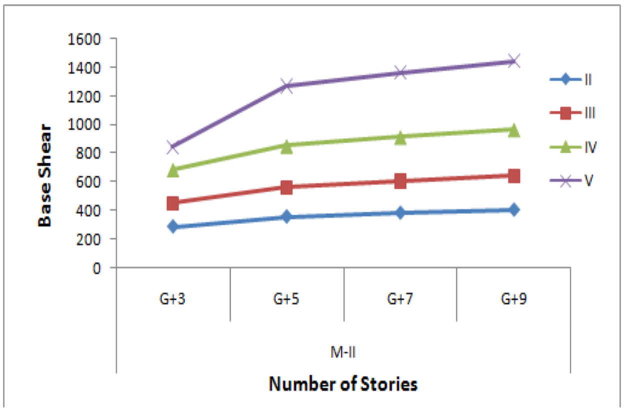

Figure.4.Base Shear variation for M-II

Observations from above variations:

1. Figure 7 and figure 8 are showing Graphical variation for various zones. As seismic zone is going up, base shear is also getting rise

2. As storey of structure increases, the base shear is also increasing.

3. In both the graphs, there is sudden raising of base shear for G+3 to G+5 but there is somewhat linear increase from G+5 to G+9.

Table.4. Storey Shear (KN) comparison for M-I and M-II for G+3

Floor	Zone-II		Zone-III		Zone-IV		Zone-V	
	9x12 (m)	**12x15 (m)**	**9x12 (m)**	**12x15 (m)**	**9x12 (m)**	**12x15 (m)**	**9x12 (m)**	**12x15 (m)**
Third	108.19	149.086	173.1	238.54	215.81	357.81	389.49	443.97
Second	63.63	86.62	101.82	138.6	121.39	207.89	229.09	257.96
First	28.28	38.5	45.25	61.6	53.95	92.4	101.82	114.65
Ground	7.071	9.63	11.31	15.4	13.49	23.1	25.45	28.67

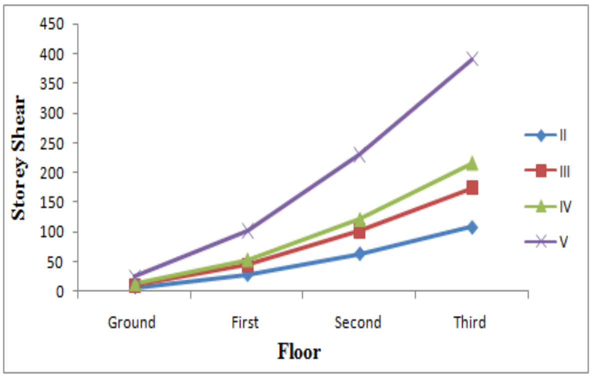

Figure.5.Storey Shear variations in G+3 for (9mx12m) plan area

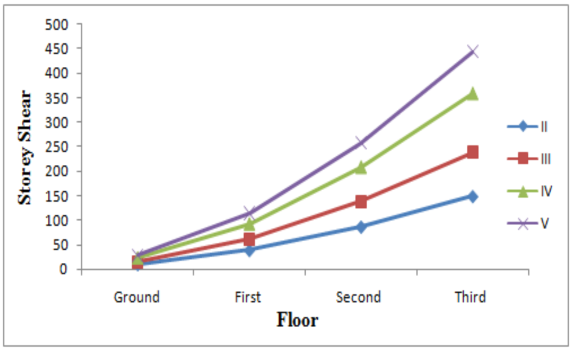

Figure.6.Storey Shear variations in G+3 for (12mx15m) plan area

Table 5.Storey Shear (KN) comparison for M-I and M-II for G+5

Floor	Zone-II		Zone-III		Zone-IV		Zone-V	
	9x12 (m)	**12x15 (m)**	**9x12 (m)**	**12x15 (m)**	**9x12 (m)**	**12x15 (m)**	**9x12 (m)**	**12x15 (m)**
Fifth	99.31	137.07	158.89	219.31	238.33	328.97	357.49	493.45
Fourth	72.11	98.32	115.38	157.32	173.06	235.97	259.59	353.96
Third	46.15	62.93	73.84	100.68	110.76	151.01	166.14	226.53
Second	25.96	35.4	41.54	56.64	62.3	84.95	93.46	127.43
First	11.54	15.73	18.46	25.17	27.69	37.76	41.54	56.63
Ground	2.89	3.93	4.62	6.3	6.93	9.44	10.38	14.16

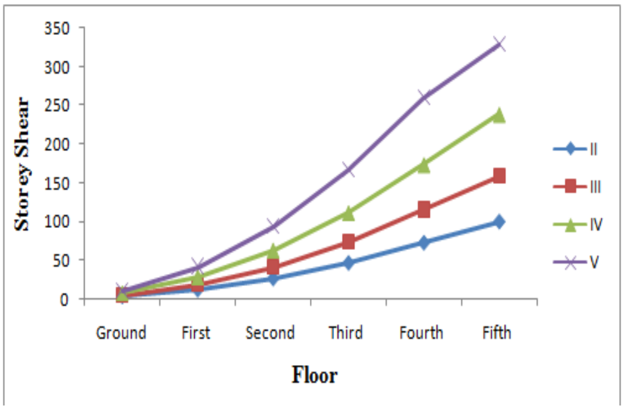

Figure.7. Storey Shear variation sin G+5 for (9mx12m) plan area

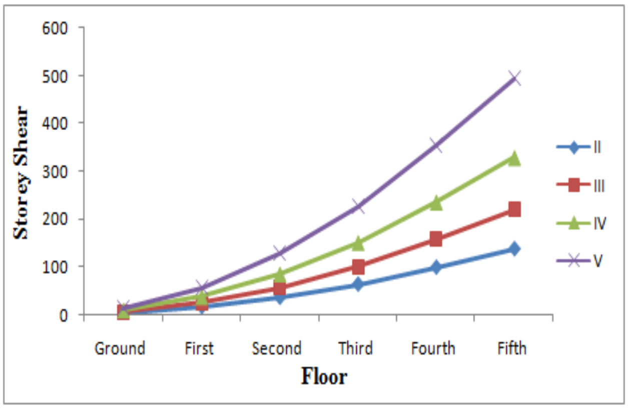

Figure.8.Storey Shear variations in G+5 for (12mx15m) plan area

Table.6.Storey Shear (KN)comparison for M-I and M-II for G+7

Floor	Zone-II		Zone-III		Zone-IV		Zone-V	
	9x12 (m)	12x15 (m)	9x12 (m)	12x15 (m)	9x12 (m)	12x15 (m)	9x12 (m)	12x15 (m)
Seventh	84.32	116.5	134.91	186.4	202.36	279.6	303.54	419.4
Sixth	67.5	92.13	108	147.41	162	221.13	243	331.67
Fifth	49.6	67.69	79.35	108.3	119.02	162.45	178.54	243.68
Fourth	34.44	47	55.1	75.21	82.66	112.81	123.98	169.22
Third	22.04	30.08	35.27	48.13	52.9	72.2	79.35	108.3
Second	12.4	16.93	19.84	27.08	29.76	40.61	44.64	60.92
First	5.51	7.52	8.82	12.03	13.23	18.05	19.84	27
Ground	1.38	1.88	2.2	3.08	3.06	4.51	4.96	6.77

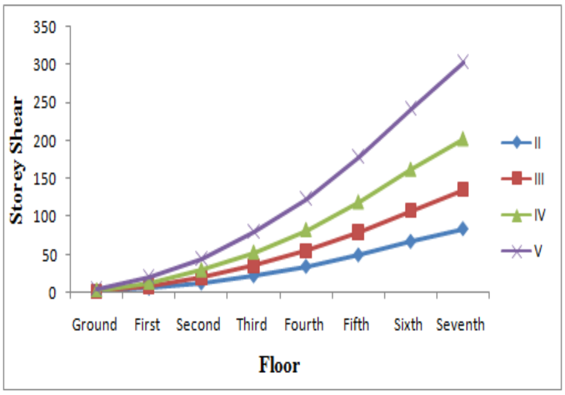

Figure. 9.Storey Shear variations in G+7 for (9mx12m) plan area

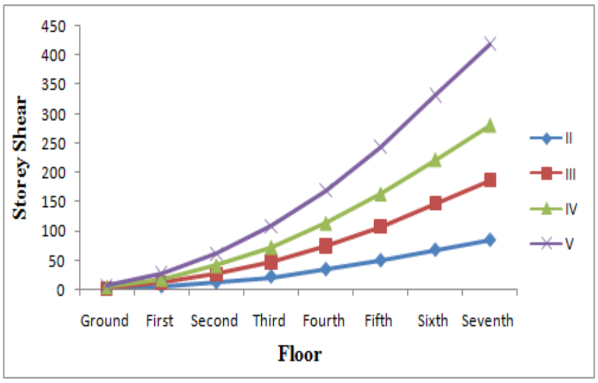

Figure.10.Storey Shear variations in G+7 for (12mx15m) plan area

Table.7. Storey Shear (KN) comparison for M-I and M-IIfor G+9

Floor	Zone-II		Zone-III		Zone-IV		Zone-V	
	9x12 (m)	12x15 (m)	9x12 (m)	12x15 (m)	9x12 (m)	12x15 (m)	9x12 (m)	12x15 (m)
Ninth	73.64	101.807	117.82	162.9	176.72	244.34	265.09	366.507
Eight	62.37	85.18	99.79	136.29	168.48	204.34	224.53	306.65
Seventh	49.28	67.3	78.85	107.68	118.27	161.63	177.4	242.29
Sixth	37.73	51.53	60.37	82.45	90.55	123.67	135.83	185.5
Fifth	27.72	37.86	44.35	60.57	66.53	90.86	99.79	136.29
Fourth	19.25	26.3	30.8	42.07	46.2	63.1	69.3	94.65
Third	12.32	16.83	19.71	26.92	29.57	40.38	44.35	60.57
Second	6.93	9.47	11.09	15.14	16.63	22.71	24.95	34.07
First	3.08	4.2	4.93	6.73	7.39	10.1	11.09	15.14
Ground	0.77	1.052	1.23	1.69	1.85	2.53	2.77	3.79

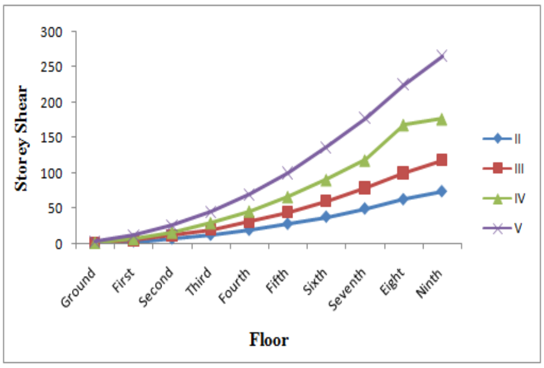

Figure.11.Storey Shear variations in G+9 for (9mx12m) plan area

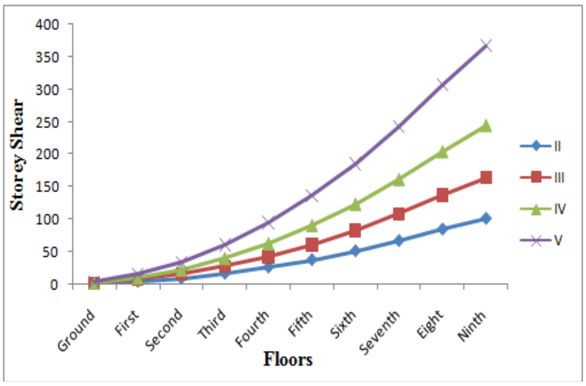

Figure.12.Storey Shear variations in G+9 for (12mx15m) plan area

Observation from above tables and graphs:

a) The storey shear graphical variations for all above cases are seen to be constant

a) It can observe that, as the seismic zone of the structure goes up, the storey shear is also rises.

b) For a same zone, as the structure height increases, the storey shear is also increases.

Table.8. Base Moment for 9mx 12m (M-I)

Storey	Zone-II	Zone-III	Zone-IV	Zone-V
G+3	46.55	68.72	82.94	152.39
G+5	55.50	83.88	125.77	188.60
G+7	59.00	90.18	135.14	202.57
G+9	61.95	95.50	143.06	214.39

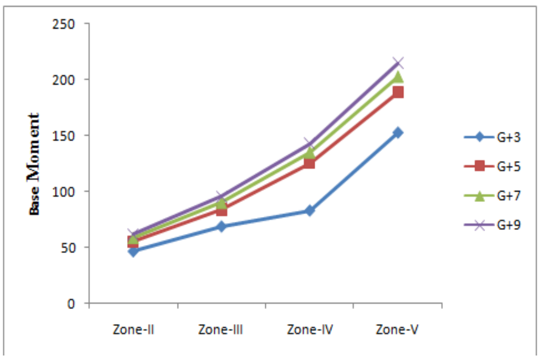

Figure.13. Base Moment variation for 9mx12m (M-I)

Table.9. Base Moment for 12mx 15m (M-I)

Storey	Zone-II	Zone-III	Zone-IV	Zone-V
G+3	71.60	104.25	149.11	184.94
G+5	83.90	123.76	182.07	273.05
G+7	88.50	130.96	194.10	291.10
G+9	92.51	137.26	204.78	307.03

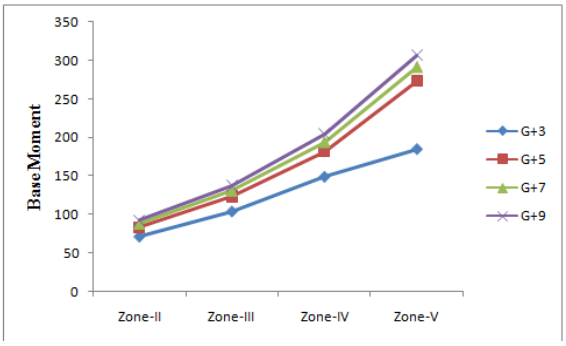

Figure.14. Base Moment variation for 12mx15m (M-I)

VIII. CONCLUSION

From the above tables and graphs it can be concluded that one has to accept that as we increase the number of storey the base shear, storey shear and base moment get increased. Also for same storey if we increase zone from zone II to zone V there is increase in base shear, storey shear and base moment and it is maximum in zone V.

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