Seismic Comparative Study of Multistoried R.C.C Building with Shear Wall in Bare Frame and Masonry Infill Frame For Various Types of Soil and Seismic Zones.

Ghalimath A.G[1], Waghmare Y.M[2], Zadbuke A.A [3], Chaudhari A.R[4]

[1] *Assistant professor, civil department, A.G.P.I.T Solapur, Maharashtra, India*
[2, 3, 4] *U.G Student, Civil department, A.G.P.I.T Solapur, Maharashtra, India*

Abstract - ***The recent earthquakes have exposed the vulnerability of the existing reinforced concrete buildings in India. The need for evaluating the seismic adequacy of the existing structures has come into focus following the damage and collapse of numerous concrete structures during recent earthquakes. In order to carry out seismic evaluation, a simplified procedure for evaluation is highly in need for a country like India which is prone to earthquakes. The static analysis procedure is applied for the evaluation of exiting design of a reinforcement concrete bare frame and frame with infill and dual system. In order to examine the performance of these models, the static analysis for seismic evaluation of existing buildings is performed. After performing the analysis parameters like natural period, base shear, displacement, axial force and bending moments in column required in each format is determined .Also it is concluded that the effect of infill plays very crucial role in seismic evaluation of existing RC buildings.it is seen that by placing shear wall, axial force &bending moment in column reduces.***

Key Words: *Bare frame, Infill Frame, Natural period, Base shear, Displacement, Axial forces, bending moments in columns, Dual system.*

1. INTRODUCTION

Amongst the natural hazards, earthquakes have the potential for causing the greatest damages to engineered structures. Since earthquake forces are random in nature & unpredictable, the engineering tools needs to be sharpened for analyzing structures under the action of these forces. India has a number of the world's greatest earthquakes in the last century. In fact, more than fifty percent area in the country is considered prone to damaging earthquakes. The northeastern region of the country as well as the entire Himalayan belt is susceptible to great earthquakes of magnitude more than 8.0.

Present study consists of (G+9) story building symmetric in plan with fixed base resting on different soil types. Shear walls are placed symmetrically in external frames. To study the influence of varying soil types and zones. Has been modeled by four alternate approaches namely,

1. Bare frame (B.F)
2. Bare frame with shear wall (B.F.W.S.W)
3. Infill frame (I.F)
4. Infill frame with shear wall (I.F.W.S.W)

Transient analysis of soil-structure system has been carried out for earthquake motion

Corresponding to all zones (i.e. II, III, and IV,V) of IS-1893.An attempt has been made to find the variation in natural period, base shear, displacement. &

Axial force and bending moments in column with and without shear wall.

2. LITERATURE REVIEW

The main objective of this work is to carry out the effect of Dual system on the seismic behavior of R.C.C. multistoried building with linear static analysis method. Following results would be compared for G+9 story building for bared frame and in filled frames. The analysis results would be compared in terms of

i) Natural period
ii) Story displacement
iii) Base shear
iv) Axial force and Bending moments in columns.

3. MODELLING ANE ANLYSIS

3.1 Problem formulation

In the analysis work four models of R.C.C. High Rise building G+9 floors are made to know the realistic behavior of building during earthquake. The length of the building is 9m and width is 9m. Height of typical story is 3m. Building is located in zone II,III,IV&V . Shear wall is provided at the center of the building to resist the earthquake. Building is designed as per IS 456-2000[17]. Material concrete grade M25 is used, while steel Fe 415 and Fe 500 are used. Masonry brick having density 20 KN/m^3 is used. Linear properties of material are considered. For the analysis work ETABS software is used. The columns are assumed to be fixed at the ground level.

Table 1: Thickness Table

Slab and wall thickness	
Slab	0.15m
Wall	0.15m
Shear wall	0.15m

3.2 schedules of R.C.C. structural members

- Column size : 0. 3m × 0.6 m
  : 0.3m × 0.55 m
  : 0.3m × 0.5m
- Size of Beam : 0.23m x 0.45m

3.3 Load considerations

- Height of building: 30m
- Numbers of bays in X-direction: 3 Nos.
- Numbers of bays in Z-direction: 3Nos.
- Grade of Concrete: M-25
- Density of Concrete: 25KN/m^3
- Density of Masonry: 20 KN/m^3
- Dead Load:
  1. Slab load=0.15x25=3.75KN/m
  2. F.F. load= 1.25x1=1.25KN/m
  3. Wall load= (3-0.45)x0.15x20=7.6525KN/m
- Live Load: 4KN/m^2

3.4Modeling of infill wall

Use of masonry infill walls located in between the columns of reinforced concrete framed structures plays a major role in the damage and collapse of buildings during strong earthquakes. Modeling of infill wall can be done by finite element method or static equivalent strut approach.

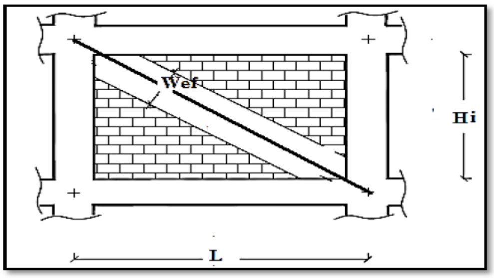


Fig -1: Diagonal strut

Paragraph The equivalent width of diagonal strut as indicated in **Fig -1** is computed, by using FEMA Approaches

FEMA Approach: In this type of modeling stiffness of wall is considered in plane of loading. For infill wall located in a lateral load resisting frame the stiffness and strength contribution of the infill are considered by modeling the infill as an equivalent strut approach given by as below

$W_{ef}=0.175(\lambda_h H)-0.4\sqrt{H^2+L^2}$

Where,

λ_h = hi $[E_i t \sin 2\theta / 4\ E_c I_c H_i]^{1/4}$

Wef = width of diagonal strut,

H, L =height and length of the frame,

Ec = elastic moduli of the column and of the infill panel,

T = thickness of the infill panel,

θ = angle defining diagonal strut,

Ic = modulus of inertia of the column,

Hi = height of the infill panel. = 1255 MPa

Ei = 1255 MPa

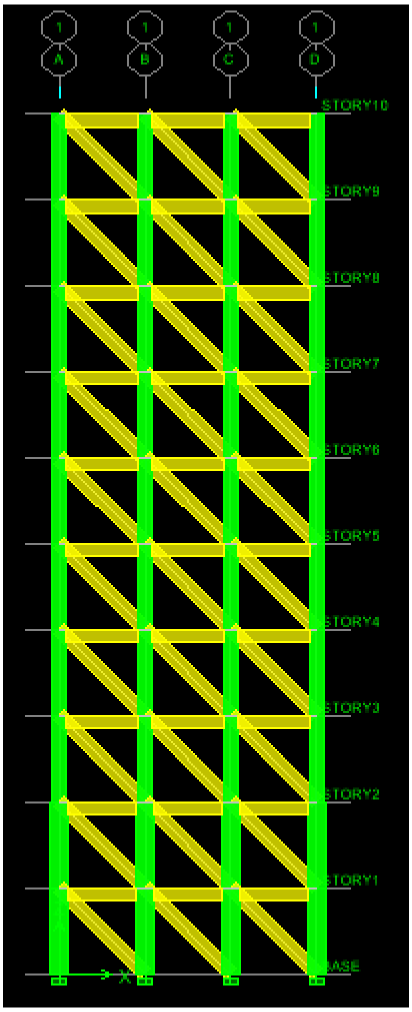


Fig -2: Elevation of infill frame

3.5 Modeling of Shear wall

Use of the shear wall centrally located in between columns of Reinforced concrete frame structure plays major role in controlling the damage and collapse of building during strong earthquake. The position of the shear wall is kept in centre of the frame. Below **Fig -3** shows the exat position of shear wall in the building.

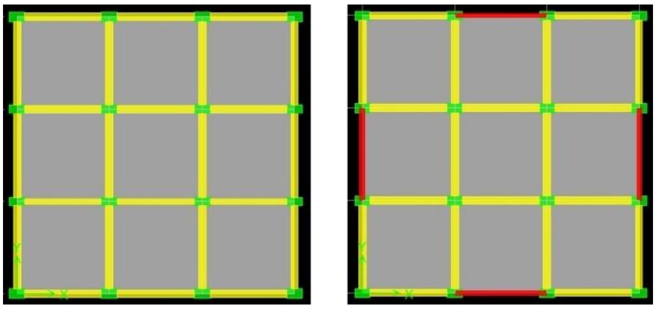


Fig -3: position of the shear wall

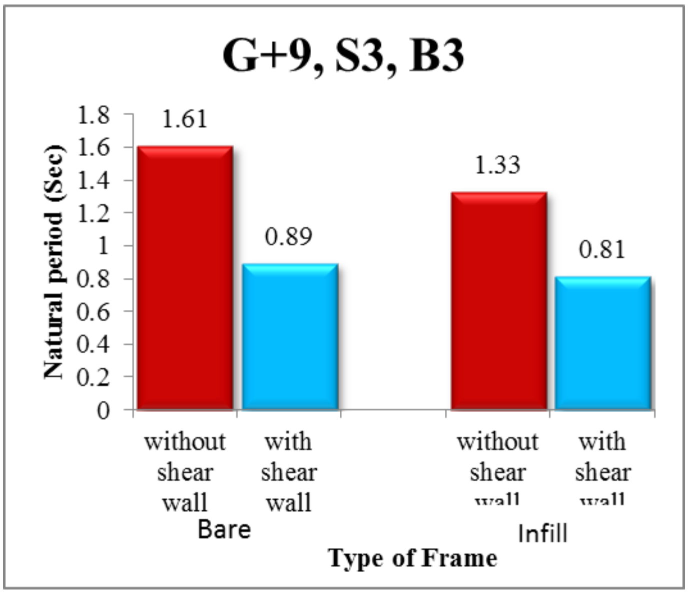
3.6 Results and Discussions:

In this discussion, graph for natural period for span 3m and3.5m and table for base shear, axial force and bending moment in column for all four types of model are represented .

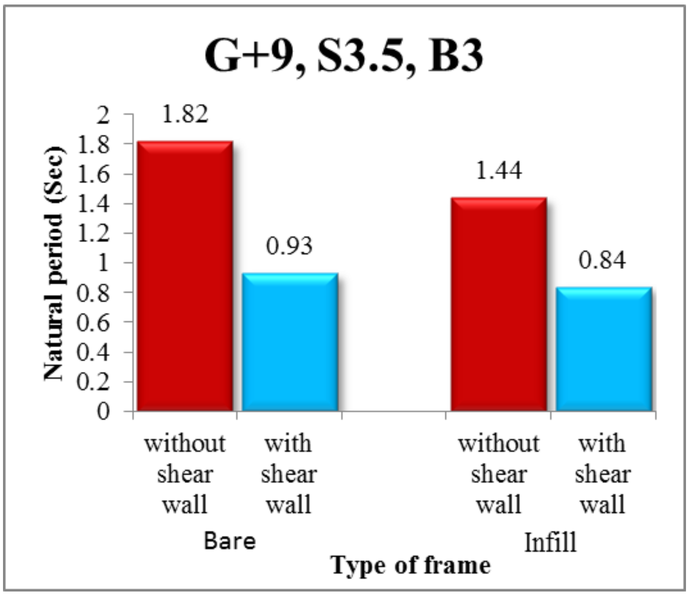
3.7 Natural period:

Following is the comparison of the natural period of building with and without shear wall for bare and infill frame,

Graph 1 - comparison of natural period



Graph 2 - comparison of natural period



3.8 Base shear:

Following is the comparison of the base shear of bare frame as well as infill frame with the Dual system.

Table 2: Comparison of Bare frame and Bare frame with Shear wall, G+9, span 3m, bay 3.

G+9, Span 3 m, Bay 3							
Zones	Base Shear	soil-I		Soil-II		Soil-III	
		Bare Frame	B.F.W.S.H	Bare Frame	B.F.W.S.H	Bare Frame	B.F.W.S.H
Zone-II	V_x	135.48	177.67	184.25	241.63	226.26	296.71
	V_y	116.43	166.91	158.35	277.001	194.44	278.75
Zone-III	V_x	216.76	284.27	294.80	386.61	361.99	474.74
	V_y	186.29	267.06	253.36	363.21	311.11	446.001
Zone-IV	V_x	325.14	426.41	442.19	579.92	542.99	712.11
	V_y	279.44	400.6	380.04	544.81	466.67	668.99
Zone-V	V_x	487.71	639.62	663.29	869.88	814.48	869.88
	V_y	419.16	600.89	570.06	817.21	700.00	817.21

Table 3: Comparison of infill frame and infill frame with Shear wall, G+9, span 3m, bay 3.

G+9, Span 3 m, Bay 3							
Zones	Base Shear	soil-I		Soil-II		Soil-III	
		Infill Frame	I.F.W.S.H	Infill Frame	I.F.W.S.H	Infill Frame	I.F.W.S.H
Zone-II	V_x	224.53	196.57	305.35	267.34	374.96	328.27
	V_y	189.09	187.54	257.16	255.47	315.78	313.7
Zone-III	V_x	359.24	314.51	488.57	427.74	599.93	525.23
	V_y	302.55	300.55	411.46	408.75	505.93	501.92
Zone-IV	V_x	538.86	471.77	732.85	641.6	899.90	787.85
	V_y	453.82	450.83	617.20	613.12	757.88	752.88
Zone-V	V_x	808.29	707.65	1099.27	962.41	1349.84	1181.78
	V_y	680.73	676.24	925.79	919.68	1136.82	1129.32

Table 4: Comparison of Bare frame and Bare frame with Shear wall, G+9, span 3.5m, bay 3.

G+9, Span 3.5 m, Bay 3							
Zones	Base Shear	soil-I		Soil-II		Soil-III	
		Bare Frame	B.F.W.S.H	Bare Frame	B.F.W.S.H	Bare Frame	B.F.W.S.H
Zone-II	V_x	123.84	205.61	168.42	279.64	206.81	343.38
	V_y	99.48	194.64	135.30	264.71	166.14	325.04
Zone-III	V_x	198.14	328.98	269.48	447.42	330.90	549.4
	V_y	159.17	311.42	216.48	423.53	265.82	520.07
Zone-IV	V_x	297.22	493.47	404.21	671.12	496.35	824.10
	V_y	238.76	467.13	324.71	635.29	398.73	780.1
Zone-V	V_x	445.82	740.21	606.32	1006.69	744.53	1236.15
	V_y	358.14	700.69	487.07	952.94	598.09	1170.16

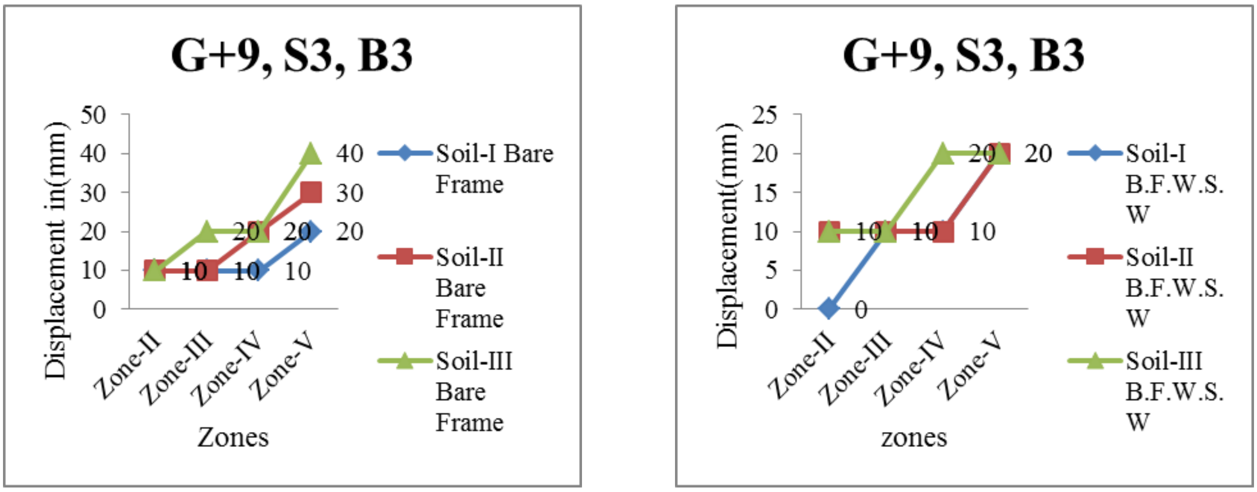
Table 5: Comparison of infill frame and infill frame with Shear wall, G+9, span 3.5m, bay 3.

G+9, Span 3.5 m, Bay 3							
Zones	Base Shear	soil-I		Soil-II		Soil-III	
		Infill Frame	I.F.W.S.H	Infill Frame	I.F.W.S.H	Infill Frame	I.F.W.S.H
Zone-II	V_x	151.39	231.47	205.88	314.8	252.81	386.56
	V_y	131.89	222.82	179.36	303.03	220.25	372.1
Zone-III	V_x	242.22	370.36	329.41	503.68	404.50	618.49
	V_y	211.02	356.51	286.98	484.85	352.4	595.37
Zone-IV	V_x	363.33	555.53	494.12	755.53	606.75	927.74
	V_y	316.52	534.76	430.47	727.27	528.60	893.05
Zone-V	V_x	544.99	833.3	741.18	1133.29	910.13	1391.61
	V_y	474.79	802.14	645.71	1090.91	792.89	1339.58

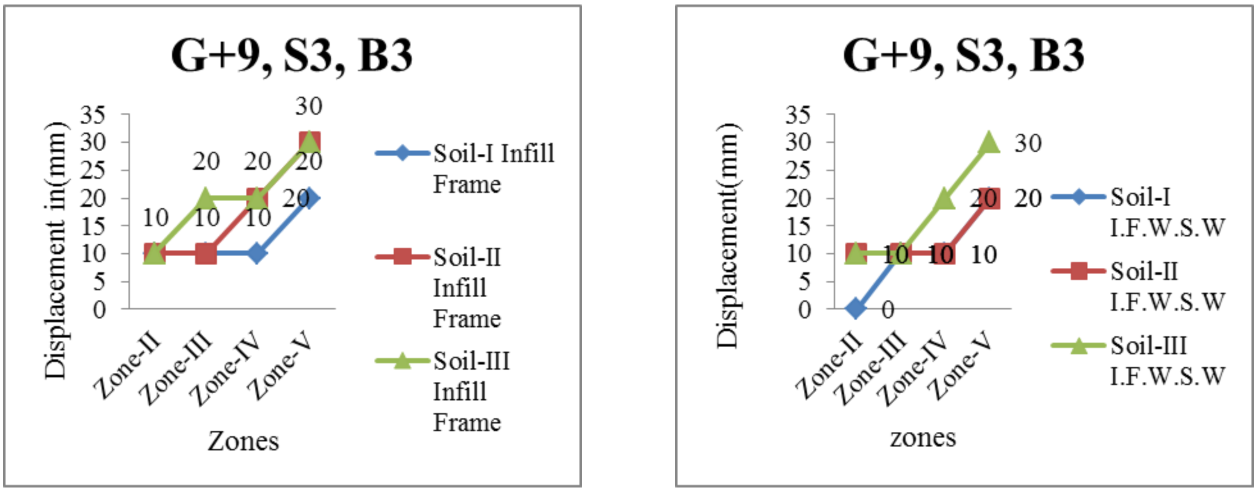
3.9 Story Displacement:

Following is the comparison of the story displacement of bare and infill frame,

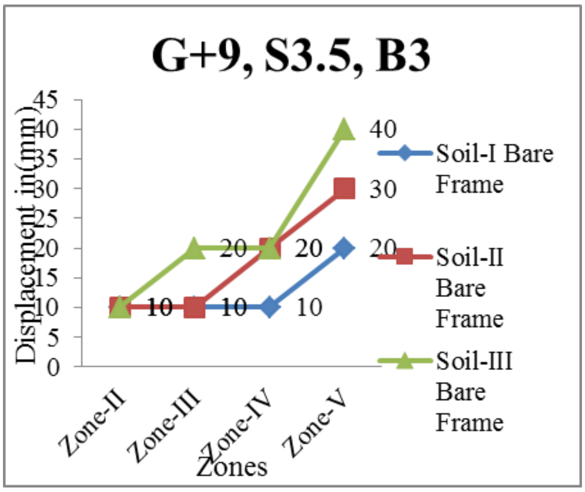
Graph 3: comparison of top story displacement in bare frame and bare fame with shear wall (B.F.W.S.W) span 3 m

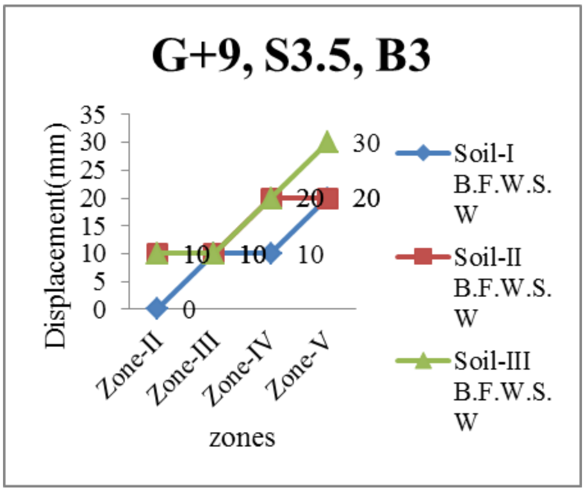


Graph 4: comparison of top story displacement in Infill frame and infill fame with shear wall (I.F.W.S.W) span 3 m

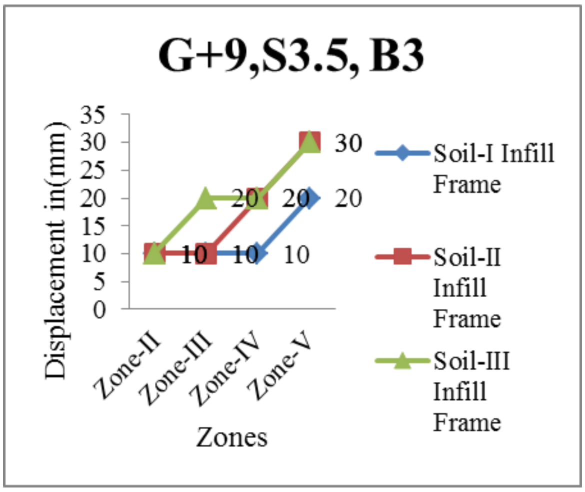


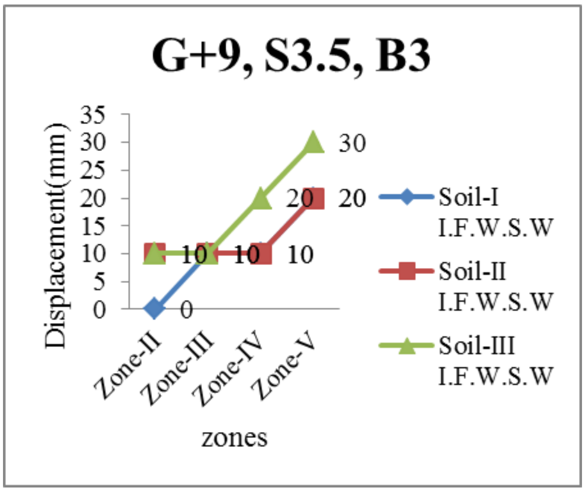
Graph 5: comparison of top story displacement in bare frame and bare fame with shear wall (B.F.W.S.W) span 3.5 m





Graph 6: comparison of top story displacement in bare frame and bare fame with shear wall (B.F.W.S.W) span 3.5





4.4 Axial forces and Design moments in Columns:

Following is the comparison of the axial force and Design moments of building with and without shear wall for bare and infill frame, for span 3m and span 3.5m.

Table 6: comparison of the axial force and Design moments of building with and without shear wall for bare frame for span 3m

Zones	G+9, Span 3 m, Bay 3											
	Soil -I				Soil -II				Soil -III			
	Bare frame		B.F with shear wall		Bare frame		B.F with shear wall		Bare frame		B.F with shear wall	
	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U
Zone-II	646.315	30.186	518.749	24.228	675.992	35.198	552.618	25.81	675.922	31.568	581.784	27.172
Zone-III	695.66	32.490	575.198	26.864	743.032	34.703	629.39	29.395	783.824	36.608	676.055	31.575
Zone-IV	761.454	35.563	650.464	30.379	832.511	38.882	731.751	34.176	1286.961	60.106	801.749	37.445
Zone-V	1154.67	40.172	763.363	35.652	1359.992	63.517	885.294	41.347	1451.774	67.804	885.294	41.347

Table 7: comparison of the axial force and Design moments of building with and without shear wall for infill frame for span 3m

Zones	G+9, Span 3 m, Bay 3											
	Soil -I				Soil -II				Soil -III			
	Infill frame		I.F with shear wall		Infill frame		I.F with shear wall		Infill frame		I.F with shear wall	
	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U
Zone-II	754.383	35.233	555.345	25.937	798.056	37.272	597.227	27.893	835.662	39.029	633.292	29.577
Zone-III	827.17	38.632	625.148	29.197	897.046	41.896	692.16	32.327	957.217	44.706	749.864	35.022
Zone-IV	924.22	43.165	718.22	33.544	1468.294	68.575	818.737	38.238	1558.55	72.791	905.293	42.281
Zone-V	1509.055	70.479	857.827	40.064	1666.275	77.822	1008.603	47.106	1801.66	84.145	1045.23	54.389

Table 8: comparison of the axial force and Design moments of building with and without shear wall for bare frame for span 3.5m

Zones	G+9, Span 3.5 m, Bay 3											
	Soil -I				Soil -II				Soil -III			
	Bare frame		B.F with shear wall		Bare frame		B.F with shear wall		Bare frame		B.F with shear wall	
	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U
Zone-II	718.552	34.292	581.6	27.756	746.39	35.621	612.838	29.247	770.362	36.765	639.736	30.531
Zone-III	764.949	36.506	633.663	30.241	809.491	38.632	683.642	32.626	847.846	40.463	726.68	34.68
Zone-IV	826.813	39.459	703.079	33.554	1338.32	63.87	778.648	37.131	1395.852	66.616	842.605	40.212
Zone-V	1364.302	65.11	807.203	38.523	1464.521	69.893	919.667	43.89	1550.82	74.011	1016.492	48.511

Table 9: comparison of the axial force and Design moments of building with and without shear wall for infill frame for span 3.5m

Zones	G+9, Span 3.5 m, Bay 3											
	Soil -I				Soil -II				Soil -III			
	Infill frame		I.F with shear wall		Infill frame		I.F with shear wall		Infill frame		I.F with shear wall	
	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U	P_u	M_U
Zone-II	859.467	41.017	625.017	29.828	904.327	43.158	667	31.832	942.956	45.002	703.152	33.557
Zone-III	934.233	44.585	694.989	33.168	1524.461	103.156	762.162	36.373	1588.851	117.468	820.006	39.134
Zone-IV	1553.54	109.619	788.285	37.62	1648.701	78.682	889.045	42.429	1741.411	83.107	975.81	46.569
Zone-V	1690.57	80.681	928.229	44.299	1852.064	88.388	1079.369	51.512	1991.129	95.024	1592.781	98.77

5. CONCLUSIONS:

Present study makes an effort to access the effect of dual system on natural period, story Displacement, base shear, axial load and design moment of column.

1. The values of natural period are reduces for dual system with as compare to bare and infill frame, hence Provisions of dual system will reduces the natural period of R.C.C. building.
2. In case of base shear, provision of shear wall in R.C.C. frame will increase the base shear as compare to the infill and bare frame.
3. Top story displacement of bare frame, infill frame and dual system are increases according to soil strata and different seismic zones
   It also concludes that provisions of infill struct and shear wall will reduce the value of story displacement in bare frame.
4. Axial forces of column are increase according to seismic zone i.e. higher seismic zone shows higher value of axial load.
   In comparison of bare frame and infill frame with dual system, the values of axial loads and design moments are reduce.
5. Axial forces and bending moment in column are reduced for shear wall as compare to without shear wall models for both bare and infill frames.

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7. BIOGRAPHIES

Ms. A.G.GHALIMATH

M.E (Structure),B.E.(civil)

Assistant professor at Civil Engineering Department. A.G.P.I.T, Solapur.

Mr. Y.M.WAGHMARE

B.E. Civil Engineering Department. A.G.P.I.T, Solapur.

Mr. A.A.ZADBUKE

B.E. Civil Engineering Department. A.G.P.I.T, Solapur.

Ms. A.R. CHAUDHARI

B.E. Civil Engineering Department. A.G.P.I.T, Solapur.