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Comparison of RC Framed Structure To Flat Slab With Shear Wall Structure

*Apexa R. Kataria **Prof. C. S. Sanghvi

*,** Applied Mechanics Department, L.D.College of Engineering, Ahmedabad, Gujarat, India

ABSTRACT

A number of significant earthquake occurred in and around the india over many years. The seismic zone maps are revised from time to time. The main moto of any structural system is to safely support gravity forces as well as earthquake forces. Now a days dual system like RC framed + shear wall structure or Flat slab + shear wall structures are widely used.

Present paper is aiming to compare above both the system under different earthquake zoning conditions to get safe and economical structural system. After many iteration for various combinations of column size and shear wall size and also location of shear wall, final iteration gives economical system with permissible deflection at each storey.

Keywords : RC Framed system, Flat slab System, Shear wall, permissible deflection

Introduction:

Earthquake produce ground motions leading to generation of inertial forces in the structures, which depends upon time and intensity of ground motions. The inertial forces generated due to earthquake ground motions need to be resisted by the structural elements in the building. Mainly these inertial forces are to be resisted by the vertical elements, and these vertical elements should be strong enough that structure can survive without failure.

The main moto of any structural system is to safely support gravity forces as well as lateral forces caused by wind, blasting or earthquake.

Reinforced cement concrete (RCC) framed structures combined with shear walls and Flat slab combined with shear wall have been widely used to resist lateral forces during earthquakes in tall buildings. Shear walls are generally provided for full height of the frames. Lateral forces are carried mostly by frames in the upper portion of the building and shear walls contribute the least in this region. This kind of structures are used for medium to high rise structure because of their high lateral stiffness.

Structural systems:

1. RC Frame Systems (Dual Systems): The system consists of reinforced concrete frames interacting with reinforced concrete shear walls.
2. Flat slab + shear wall systems: Slabs supported directly on the column without beams called flat slab. This system is the combination of flat slab and shear wall.

Shear wall:

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure.

As part of an earthquake resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three dimensional stability for the building structures.

Problem formulation for compare two different systems :

To compare RC Framed structure with flat slab analysed two buildings using software "ETABS":

- RC framed with shear wall
- Flat slab system
- Flat slab with shear wall

General information regarding the buildings are as given below.

Floor of building	:	(G+10 storey)
Height of building	:	38.5 MT
Typical storey height	:	3.5 MT
Dimension of building	:	28 MT X 24 MT

Building was symmetrical in plan; Brick masonry was used as an infill panel. Buildings were used for residential purpose. Architectural plan was given in Fig. 1 on the basis of the architectural plan of typical floor level and sectional elevation, structural layout of typical floor level was prepared.

Loading Data:

Dead load

Thickness of slab	:	125 mm
Self weight of slab	:	3.0 KN/M2
Floor finish	:	1.0 KN/M2
Total	:	4.0 KN/M2
Live load	:	4.0 KN/M2

Wall load

230 mm thick wall	:	16 KN/M2
115 mm thick wall	:	8 KN/M2

Earthquake load

Earthquake zone	:	V
Zone factor	:	0.36
Important factor	:	1.5

Special moment resisting frame

Response reduction factor : 5.0

Load cases

Dead load

Live load

Earthquake load

Load combination

1.5 Dead load + 1.5 Live load

1.5 Dead load + 1.5 Live load + EQ load

And others combinations.

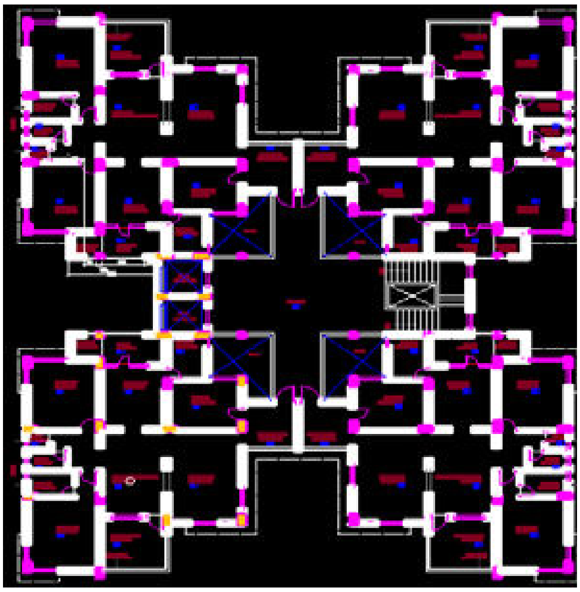


Figure 1 RC framed structural system

Here are the lateral deflections of each storey after analysed the all three structure in software “ETABS”.

Table-1 Point Disp. In X-Dir For Z-5

Story	UX-R-Z5	UX-FS-Z5	UX-FWS-Z5
PB	33.9946	15.8318	1.8059
FF	52.1181	39.5024	7.426
SF	70.3641	77.4576	16.2393
TF	89.0106	119.0397	27.3655
4F	107.6326	161.3281	40.12
5F	125.7983	202.853	53.9165
6F	143.0252	242.3564	68.1767
7F	158.7813	278.564	82.5075
8F	172.4925	310.1634	96.591
9F	183.5917	335.9058	110.2904
TER	191.8740	355.3002	123.5208

Table:2 Storey Drift in X-dir

Story	DriftX-R Z5	DriftX-FS5	DriftX-FWS Z5
TER	0.00239	0.00566	0.00534
9TH	0.00323	0.00746	0.00547
8TH	0.00398	0.00913	0.0056
7TH	0.00456	0.01044	0.00566
6TH	0.00498	0.01137	0.0056
5TH	0.00524	0.01194	0.00539
4F	0.00536	0.01214	0.00496
TF	0.00536	0.01192	0.00431
SF	0.00527	0.01085	0.0034
FF	0.00563	0.00676	0.00215
PB	0.01134	0.00528	0.0008

Comparison of Different Diaphragm Systems:
We know that earthquake develops inertia forces in the structure. Inertia of the structure is depend on the mass. Inertia forces become lateral forces during the earthquake Which results significant lateral displacements produced in the structure.

Here All three structures are analysed under zone-5 conditions. Figure:3 shows the point displacements in X-direction at each storey for all three systems.

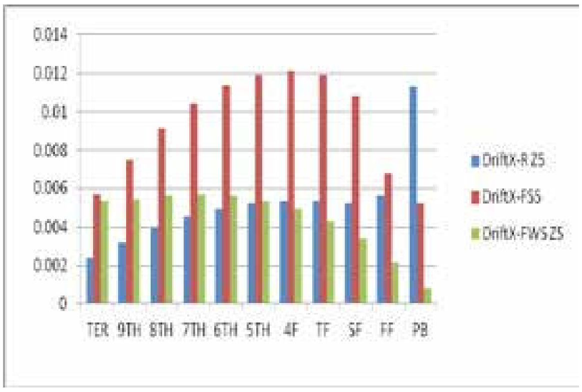


Figure: 2 Point Disp. In X-Dir for Z5

Figure:4 shows the storey drift at each storey for all three systems. The permissible storey drift is 0.004 times the storey height for seismic loading as per IS 1893-2000.

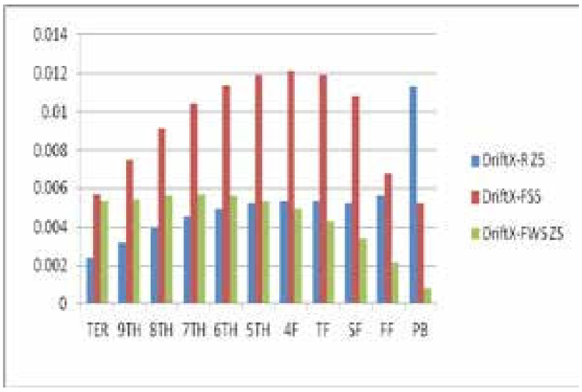


Figure: 3 Storey drift in x-dir for Z5

The number of iterations carried out of various combinations of column size, shear wall size and placement of shear wall for get safe and economical structure among all the three type of structural systems.

This preliminary design is carried out for the systems considered under the given loading conditions as per IS 13920 and IS 456-2000.

Final iteration give economical size of columns and reinforcement area with permissible deflection of each story.

Also the requirement of steel and concrete for all three systems are calculated from design output provided by ETABS. The results are as follows:

Here given the table for requirement of material as per c/s area and element type for all three systems.

SYSTEM	COST OF CONC Rs. 5000/M3	COST OF STEEL Rs. 42/ KG	TOTAL COST IN RS.
REG-5	12811670	14608234.2	27419904.2
FS-5	9543122.2	11985963.39	21529085.59
FWS	9470341	10935935.08	20406276.08

Table :3 Total weight of material for RC Framed system

Section	Ele Type	Num Piece	Conc. M^3	Steel kg
0.6X0.3	Col	176	103.143	25785.83
0.3X0.60	Col	506	296.537	74134.26
0.9X0.35	Col	110	96.6968	24174.22
WB	Beam	1430	906.285	135942.7
B1	Beam	297	202.197	30329.63

S1	Floor		957.474	57448.45
			2562.33	347815

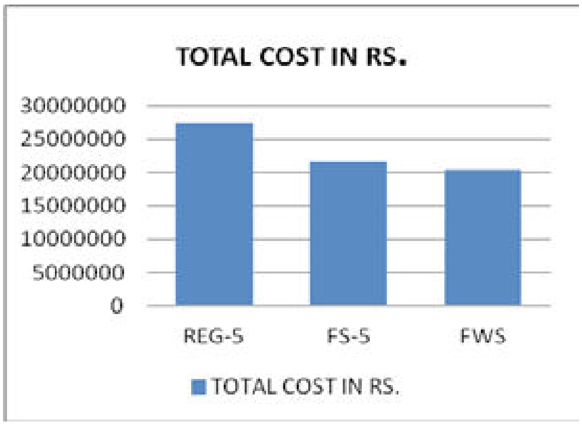
Table:4 Total weight of material for Flat slab system

Section	Ele Type	Num Pieces	Conc. M^3	Steel kg
0.9X0.35	Col	176	180.500	45125.2
0.35X0.9	Col	506	518.939	129735
0.75X0.3	Beam	147	70.242	10536.3
0.9X0.35	Col	110	96.6968	24174.22
PB1	Beam	157	94.8644	14229.67
FS	Floor		947.380	61579.73
			1908.62	285380.1

Table:5 Total weight of material for Flat slab with shear wall system

section	Ele Type	Num Pieces	CONC. M^3	STEEL kg
.6X.3	Col	176	103.1433	25785.83
.3X0.6	Col	506	296.537	74134.26
.3X0.6	Beam	44	25.05976	3758.964
0.75X0.3	Beam	147	85.26076	12789.11
PB1	Beam	157	100.1173	15017.6
W230	Wall		336.5696	67313.91
FS	Floor		947.3804	61579.73
			1894.068	260379.4

Table :6 Total Cost of All Three System



After getting quantity of material the cost of the all three structural system easily find out using the running rate of different material from market.

Conclusion:

- It could be seen that the Point displacement produced in the Regular (framed) system and flat slab system is maximum than the flat slab + shear wall system for any story height.
- It could be also seen that the storey drift produced in the Regular (framed) system and Flat slab system is maximum Than flat slab with shear wall System.
- It is also clearly visible that the lateral deflection does not exceed the limit as specified by IS-456-2000 (clause 20.5) for the final iteration for the given system for different storey height
- Flat slab with shear wall system has very less amount of lateral deflection than the other two system at each storey height. This system gives more clear height than the regular (framed) system because of absence of beam in that. So in that case the clear height of storey may be reduced in the system. Also can add some number of storey in the high rise structure for flat slab with shear wall system.
- From the material quantity it is found that the flat slab with shear wall system is safe and most economical than among all.

Future Scopes:

· For the high rise structure increase no of shear wall in flat slab with shear wall system to get benefit of increment in no. of storey.

· The effect of infill wall can be considered for future study.

· Instead of flat slab with shear wall system use post tensioned slab system for analyse the structure to get economical and get more safe system.

REFERENCES

Thomas Paulay and M. J. N. Priestley, Seismic Design of Reinforced Concrete and Masonry Building, a Wiley-Inter science Publication. | Dr. V. L. Shah and Dr. S. R. Karve, Limit State Theory and Design of Reinforced Concrete, Fourth Edition, Structure Publications, 2003 | C. V .R. Murty, "Shortcomings in structural design provisions of IS456:2000", The Indian Concrete Journal, February 2001. | IS: 456-2000, PLAIN AND REINFORCED CONCRETE CODE OF PRACTICE, Fourth Revision, BUREAU OF INDIAN STANDARD. | IS: 1893-2002 (Part-I), CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES, Fifth Revision, BUREAU OF INDIAN STANDARD. | K. Pilakoutas and X. Li, "Alternative shear reinforcement for reinforced concrete flat slab", Journal of Structural Engineering,vol.129, No.9, September 2003, ASCE, pp. 1164- 1172. | A.J. Durani et al, "Earthquake response of flat slab buildings", Journal of structural Engineering, Vol. 120, March 1994, ASCE, pp. 947- 964.