Dynamic Analysis of Multistory Building with and Without Shear Wall and Bracing System

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***Abstract*—Rapid growth of urban population and lack of availability of land tends to produce shortage of land and high cost of land hence to overcome these crises high rise structures are preferred. Along with vertical loads such as self weight of structure, live load; structure has to resist the horizontal loads such as seismic load and wind load. There are different types of lateral load resisting systems such as shear wall, outrigger, bracing, hexagrid, diagrid, rigid frame, etc. According to site condition, types of building these systems are used. In this study Shear wall system and Bracing systems are used for 25 stories multistory building different types of shear wall and bracing systems are used for analysis. The analysis of building is done by linear dynamic method i.e. response spectrum method.**

***Index Terms*—bracing system, ETAB, lateral load resistance, response spectrum, Seismic, shear wall.**

I. INTRODUCTION

The lateral load resisting systems that have universally used are rigid frame, shear wall, diagrid structural system, braced tube system, wall frame and outrigger system. Recently shear wall systems and bracing system are the most commonly used lateral load resisting systems. Due to presence of high stiffness and strength shear wall system provides resistance to lateral load and supports to gravity loads. At the same time, the bracing systems is have less stiffness comparing with shear wall system but there is a main concern that the weight of bracing system is less as comparing with concrete shear wall. As per assumptions, it is considerably noted that less self-weight causes less story shears and results superior performance.

Previously, Christakas K. I. (2017) discussed on designing of walls is done according to older seismic codes. For this purpose, a series of four shear walls, typical medium-rise walls, was designed and tested as considering as cantilevers under static cyclic loading. The walls are differed by type of reinforcement provisions, mainly focusing on various amounts of shear reinforcement and on the buckling of the compressive longitudinal rebar. The experimental results are has been compared with the provisions provided in Euro code 8 – Part 3 by estimating the strength and deformation capacity of existing reinforced concrete structural members.[1]

Krishnaraj R.(2014) carried seismic analysis RC building of seven stories (G+6) using the software STAAD pro V8i. The load cases considered in the seismic analysis areas per IS 1893 – 2002. The different types of bracing systems are used in analysis of structure such as, X-bracing, inverted V-bracing, V-bracing, diagonal bracing. It is concluded that, using steel bracings the total weight on the existing building will not change significantly. The X-Type steel bracing reduces lateral displacement of the building up to 50–56 percent. [3]

Mirghaderi S. R. (2008) studied shear wall with irregular openings under both lateral and gravity loads and May result in performances of structural elements such as shear walls, coupling beams etc. For a seismic evaluation, a lot of non-linear analyses were performed to verify its behaviour with the most prevalent retrofitting guidelines like FEMA 356. Aspects of the tower with the assessment of its seismic load-bearing system are discussed with considering some important factors. [6]

II. BUILDING DETAILS

In this project 25 number of stories building is considered for analysis. The story height of building is 3.6m and total height of building is 87m.The plan area of building is 25X20m. The c/c distance between columns in X-direction is 5m and in Y-direction 4m.

In shear wall system, three types of shear wall considered such as L type shear wall, C type shear wall and Shear wall along periphery. Similarly, in bracing system, three types of bracing systems considered such as X-type bracing system, inverted V-type bracing system and diamond K-type bracing system. The analysis of all the models is performed on using ETABS software. The live load and floor load are 4KN/m^2 and 1.7KN/m^2 respectively. The seismic zone considered is zone V with zone factor 0.36. Soil type is medium; response reduction factor considered is 5 and importance factor 1.2.

Structural Member	Properties
Column Size	900X900, 530X750(mm)
Beam Size	300X750(mm)
Slab thickness	200mm
Shear wall thickness	230mm
Bracing Member	ISA110X110X10
Flore Height	3.6m

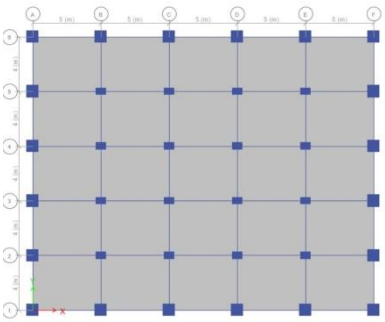

Fig.1 (a) Floor Plan of Structure

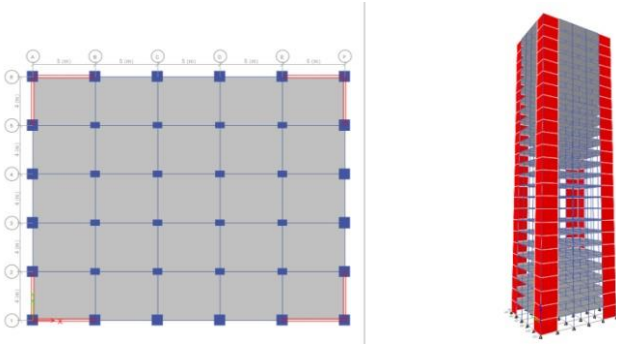

Fig.1 (b) Floor Plan and elevation of L-Type Shear wall Structure

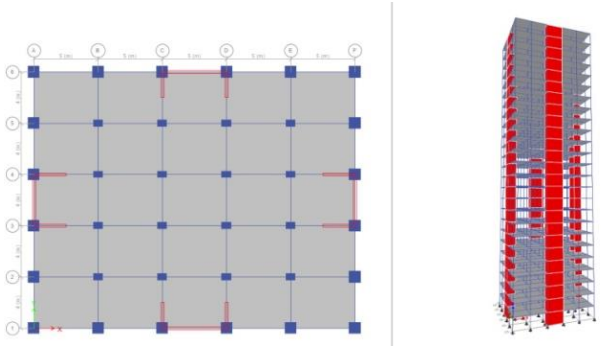

Fig.1 (c) Floor Plan and elevation of C-Type Shear wall Structure

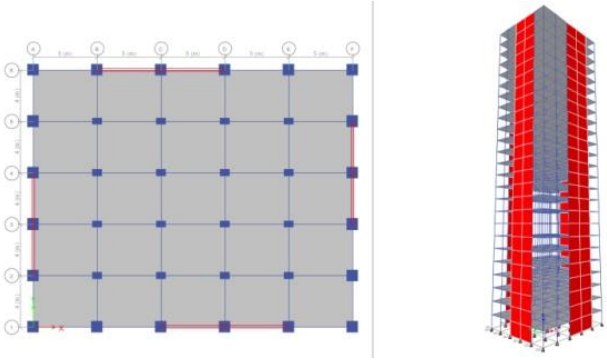

Fig.1 (d) Floor Plan and elevation of Shear wall along periphery Structure

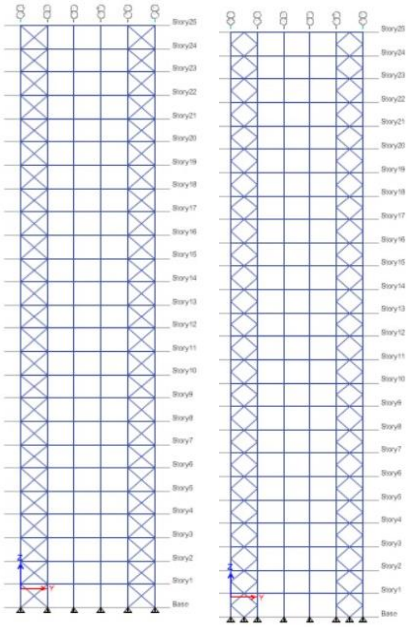

Fig.2 (a) Fig.2 (b)

Fig.2 (a) Elevation of X-Type Bracing system

Fig.2 (b) Elevation of K-Diamond Bracing System

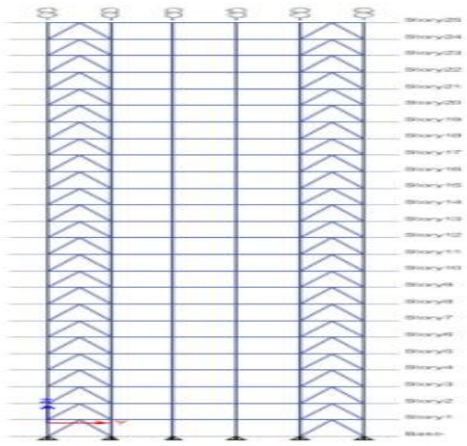

Fig.2 (c) Elevation of Inv. V-Type Bracing system

III. ANALYSIS, RESULT AND CONCLUSION

Linear dynamic method is adopted for analysis of structure. For dynamic analysis response spectrum method is used. Results of analysis are compared in terms of story displacement, story drift and Story shear.

A. STORY DISPLACEMENT

As per IS 1893:2016, maximum allowable displacement of structure should be H/250 for seismic loading and for wind load it should be H/500. Where, 'H' is height of the structure. In this study, height of structure is 87 meter. The maximum seismic displacement is 87/250 = 348mm and maximum wind load displacement is 87/500 = 0.0144.

1.In Shear wall System:

Load Type	Normal Building	Shear Wall Type		
		C-Type	L-type	Along Periphery
Eq. X	291.01	134.440	138.68	105.86
Eq. Y	279.06	150.980	156.32	127.26

Table 1(a) Max. Story Displacement in Shear wall System

Fig.3 (a) Story Displacement for shear wall system

2.In Bracing System:

Load Type	Normal Building	Bracing Type		
		K-Diamond Type	Inverted V-Type	X-type
Eq. X	291.01	134.440	138.68	105.86
Eq. Y	279.06	150.980	156.32	127.26

Table 1(b) Max. Story Displacement in Bracing System

Fig.3 (b) Story Displacement for bracing system

Fig.3 (a) and Fig.3 (b) represents story displacement for shear wall and bracing system. Normal building without any load resisting system, shows maximum story displacement in both X and Y direction. Structure with shear wall along periphery shows less displacement in X and Y direction as compared to other structures. In bracing system, X-type of bracing system shows less displacement in both X and Y direction.

B. STORY SHEAR

1. In Shear wall System:

Load Type	Normal Building	Shear Wall Type		
		C-Type	L-type	Along Periphery
Eq. X	6.34	6.72	6.610	6.723
Eq. Y	6.343	6.72	6.610	6.723

Table 2(a) Max. Story Shear in Shear wall System

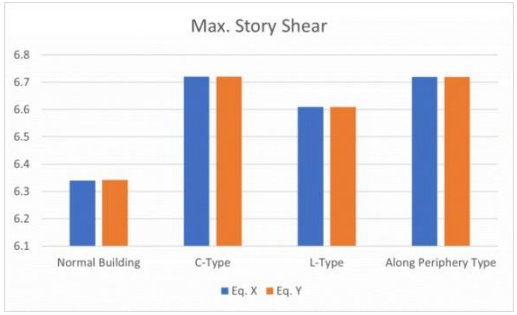

Fig.4 (a) Story shear for Shear wall System

2. In Bracing System:

Load Type	Normal Building	Bracing Type		
		K-Diamond Type	Inverted V-Type	X-type
Eq. X	6.34	6.230	6.220	6.231
Eq. Y	6.343	6.230	6.227	6.231

Table 2(b) Max. Story Shear in Bracing System

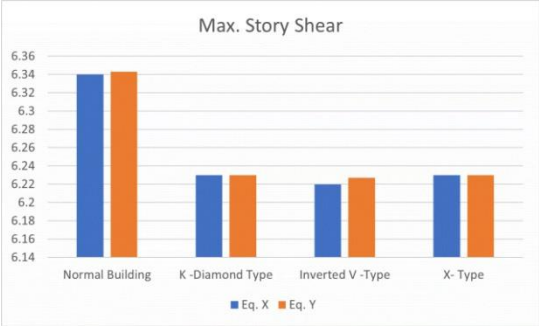

Fig.4 (b) Story shear for Bracing system

Fig.4 (a) and Fig.4 (b) represents story shear for shear wall system and bracing system. For shear wall system, maximum base shear is seen in structure with shear wall along periphery and for bracing system maximum base shear is X-type of bracing system. As stiffness of system increases story shear also increases.

C. STORY DRIFT

As per IS 1893: 2016, maximum story drift in any story should not more than 0.004 times story height. Here, maximum story drift of structure is 0.004X3.6=0.0144.

1. In Shear wall System:

Load Type	Normal Building	Shear Wall Type		
		C-Type	L-type	Along Periphery
Eq. X	0.00635	0.00187	0.0019	0.00148
Eq. Y	0.00611	0.00083	0.00216	0.00170

Table 3(a) Max. Story Drift in Shear wall System

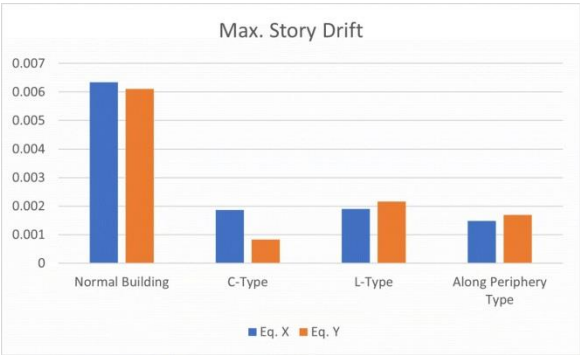

Fig.5 (a) Story drifts for shear wall system

2. In Bracing System:

Load Type	Normal Building	Bracing Type		
		K-Diamond Type	Inverted V-Type	X-type
Eq. X	0.00635	0.00301	0.00351	0.00302
Eq. Y	0.00611	0.0030	0.00382	0.00307

Table 3(b) Max. Story Drift in Shear Bracing System

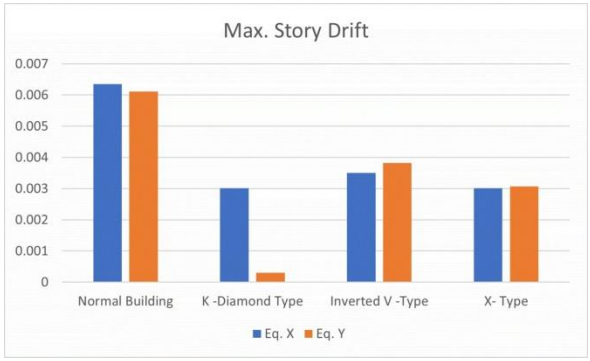

Fig.5 (b) Story drifts for bracing system

Fig.5 (a) and Fig.5 (b) represents story displacement for shear wall system and bracing system. In shear wall system, shear wall along periphery shows less story drift and in bracing system, structure with X-type bracing system shows less story drift.

IV. CONCLUSION

From the above study following conclusions were drawn.

1. In Shear wall System,
   a. Shear wall along the periphery performs better among the models.
   b. Displacement is reduced about 53% as compared to normal building without any lateral load resisting system.
   c. Max story drift is 0.00148 is seen which is about one fourth times less as compared to normal building.
2. In Bracing System,
   a. Building with X-Type of bracing performs better among the models.
   b. Displacement seen is reduced about 30% as compared to normal building.
   c. Max story drift seen is 0.00302 which is half as compared to normal building.
3. Overall results shows shear wall along with periphery system is more efficient than building with bracing system.

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