Study on Effective Bracing Systems for High Rise Structures Using E-TABS

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Abstract: This work deals with the study of time history analysis of multi-storey residential structure with different types of bracings by using software E-Tabs.The RCC structure is take of G+15 Story residential structure. The analysis of seismic is done by using IS1893-2002 from Zone III. Nextly,the performance point is obtained by using Non-linear time history analysis with respect to Bhruj earthquake in 2001.The results is taken by compression is done between normal bracings with respect to maximum displacement, story shear, and time period.

Keywords: Seismic Analysis, bracing system, ETABS 2016, Non-Linear Time History Analysis(FEN).

1. INTRODUCTION:

In India most of the building structures fall under the category of low rise buildings. So, for these structures reinforced concrete members are used widely because the construction becomes quite convenient and economical in nature. But since the population in cities is growing exponentially and the land is limited, there is a need of vertical growth of buildings in these cities. So, for the fulfilment of this purpose a large number of medium to high rise buildings are coming up these days. In the present time, Previous earthquakes in India show that not only non-engineered structures but engineered structures need to be designed in such a way that they perform well under seismic loading. Bracing can be applied as concentric bracing or eccentric bracing. There are 'n' number of possibilities to arrange steel bracings, such as cross bracing 'X', diagonal bracing 'D', and 'V' type bracing. Under severe earthquake loading ductile fracture at beams and columns connections are common. Moment resisting frames have low elastic stiffness. Reinforced concretes frames are used in low rise buildings because loading is nominal. But in medium and high rise buildings, the conventional reinforced concrete construction cannot be adopted as there is increased dead load along with span restrictions, less stiffness and framework which is quite vulnerable to hazards.

The use of steel bracing system is one of the commonly used system-level rehabilitation techniques. Steel bracing systems have both practical and economic advantages. The main advantage of this method is that it is not required to rehabilitate the foundation system. Since the bracing system does not introduce great additional gravity load to the existing structure and steel bracings are usually installed between existing vertical members. However, increased loading on the existing foundation is possible at the bracing locations and the greater foundation forces are generated in the retrofitted frames under lateral loads so the foundation still must be evaluated. Furthermore, if it is used external steel systems the minimum disruption of the building is obtained.

NEED FOR PRESENT STUDY

Most of the reinforced concrete structures were designed primarily for gravity loads. They were also designed for lateral forces that may be much smaller than that prescribed by the codes and this needs additional supporting element in the design of RC frame such as; bracing RC frame by steel bracing which act as shear resisting element for the design of new RC building. And for retrofitting of existing structure in the case of an inadequate seismic load capacity of existing RC structure. In such case some bracing systems are more effective or give better results than other bracing system in resisting all the horizontal loads, therefore among the main bracing systems which are most efficient in resisting seismic load.

OBJECTIVE OF THE STUDY

The present work aims at the following objectives:

- The main objective of this thesis is to compare and evaluate the effectiveness of different types of steel braced reinforced concrete systems at different locations. Under earthquake lateral loads.
- Study of Seismic demands of regular R.C and different types of steel bracing in R.C.C structure by using static and Non-linear time history analysis.
- It is to identify the most efficient and suitable lateral loads resistant steel bracing types which give the minimum lateral displacements, minimum story drift and which increase shear capacity of RC and Steel frame from the selected groups of bracings types.
- Comparative study has been done in term of roof displacement,time periods.

SCOPE OF THE STUDY

The present work aims at an objective demonstrating the effect of different type of bracing system for symmetric high rise structures. The building studied in this section is 15-storey Reinforced concrete Designed for Gravity and Seismic Loads Using Linear Analysis. The structure is evaluated in accordance with seismic code IS-1893:2002 using Non-linear time history analysis with the help of the Etabs2016 software (CSI Ltd) analysis engine. The primary goal of this thesis is to provide useful insights into the current development of high performance braces in the hope that such system can be more widely adopted and utilized by practicing engineer in designing new earthquake resistance structure.

2. METHODOLOGY:

BUILDING DESCRIPTION

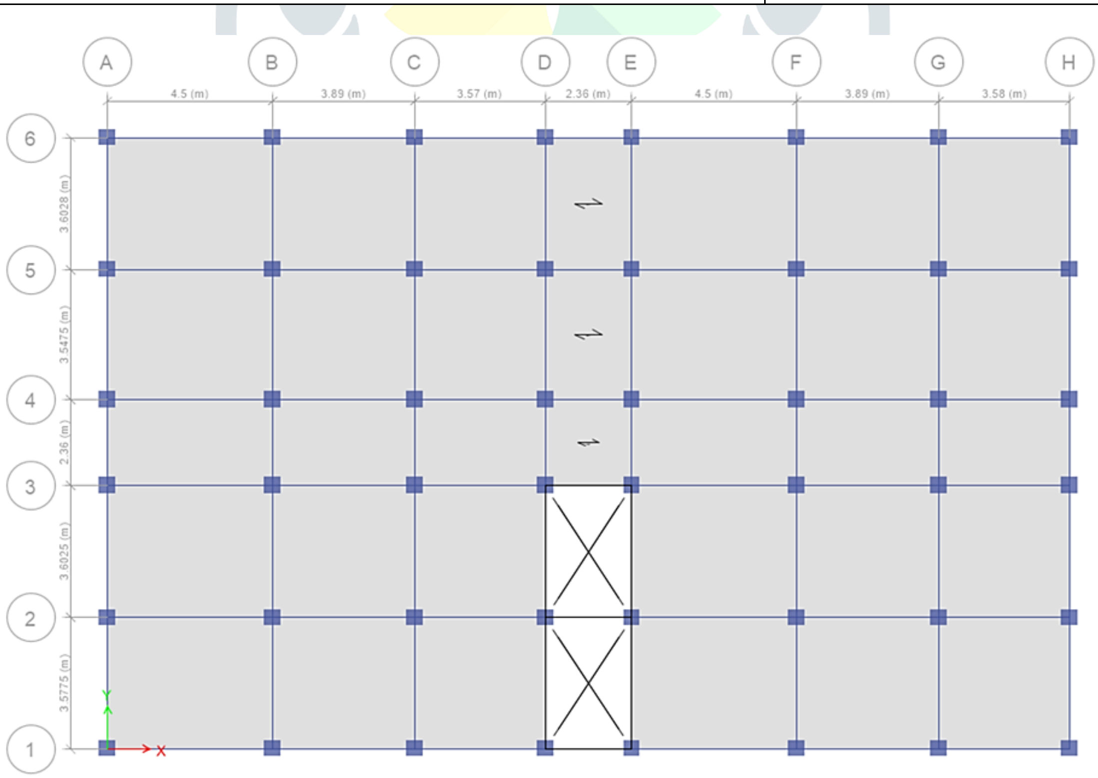
A G+15 storied reinforced concrete frame building situated in zone IV, is taken for the purpose of study. The plan area of building is 26.29x 16.69m with 3m as height of each typical storey. It consists of 7 bays in X-direction and 5 bays in Y-direction. The total heights of the buildings were 46.5m.

Model 1: RCC without bracing.
Model 2: RCC with X-bracings.
Model 3: RCC with inverted V-bracings.
Model 4: RCC with Eccentricity Back bracings.
Model 5: RCC with Eccentricity Forward bracings.

2.1 STRUCTURAL SYSTEM OF THE BUILDING

The column, beam dimensions are detailed in the below tables:

Structural details of G+15 Concrete Structure	
Specifications	15 Storey
Slab thickness	125 mm
Beam dimensions	300x450 mm
Column dimensions	450x450 mm
Grade of concrete	M25
Grade of steel	HYSD415
Unit weight of concrete	25 KN/m^3
Live loads	2.5 KN/m^3
Importance factor	1.0
Seismic zone factor	0.16
Response reduction factor	5
Bracing	ISMB250

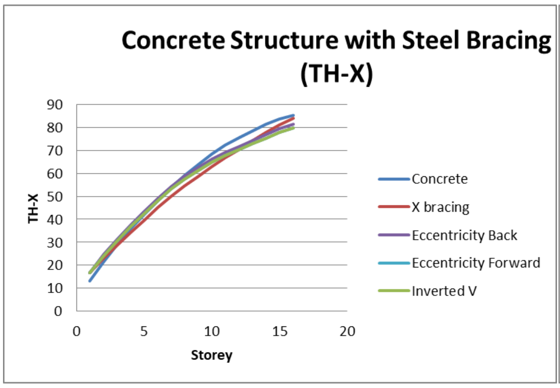


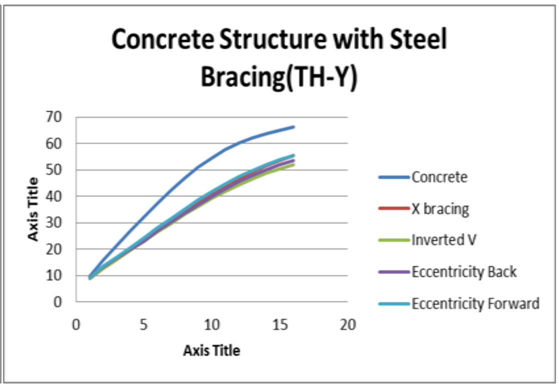
3. ANALYSIS RESULTS:

Time History Analysis for Concrete Structure with Steel Bracing (THX&THY)

Maximum Story Displacements					
Storey	TH-X				
	Concrete	X bracing	Inverted V	Eccentricity Back	Eccentricity Forward
Storey1	13.128	16.673	16.602	16.813	17.056
Storey2	21.619	23.079	24.14	24.63	24.131
Storey3	28.908	28.629	30.456	31.125	30.028
Storey4	35.73	34.257	36.663	37.44	35.912
Storey5	42.166	39.771	42.584	43.476	41.627
Storey6	48.196	45.057	48.11	49.1	47.024
Storey7	53.798	50.023	53.139	54.219	52.006
Storey8	59.112	54.631	57.608	58.768	56.501
Storey9	64.03	58.893	61.506	62.729	60.499
Storey10	68.427	62.882	64.864	66.149	64.043
Storey11	72.259	66.711	67.784	69.129	67.237
Storey12	75.542	70.482	70.408	71.828	70.245
Storey13	78.546	74.186	72.893	74.411	73.192
Storey14	81.367	77.732	75.328	76.967	76.08
Storey15	83.635	81.007	77.733	79.425	78.79
Storey16	85.212	83.845	79.835	81.561	81.12

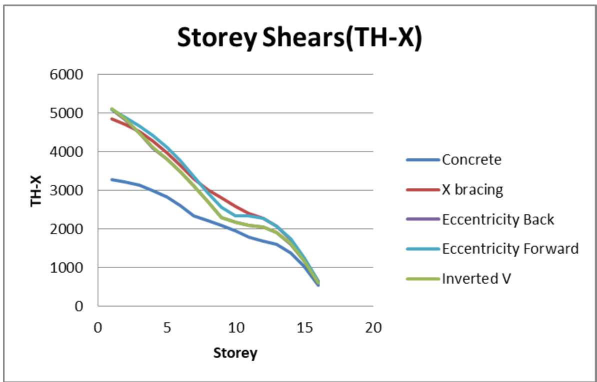
Maximum Story Displacements					
Storey	TH-Y				
	Concrete	X bracing	Inverted V	Eccentricity Back	Eccentricity Forward
Storey1	9.625	9.514	8.761	9.061	9.233
Storey2	15.889	13.124	12.61	13.175	13.529
Storey3	21.44	16.49	15.996	16.617	17.123
Storey4	26.854	19.998	19.497	19.974	20.636
Storey5	32.198	23.56	23.029	23.245	24.427
Storey6	37.424	27.121	26.518	26.817	28.156
Storey7	42.414	30.643	29.908	30.304	31.782
Storey8	47.016	34.096	33.16	33.676	35.272
Storey9	51.118	37.453	36.251	36.909	38.606
Storey10	54.662	40.679	39.166	39.98	41.76
Storey11	57.66	43.738	41.89	42.866	44.715
Storey12	60.154	46.595	44.41	45.543	47.448
Storey13	62.211	49.222	46.706	47.984	49.934
Storey14	63.885	51.599	48.754	50.159	52.148
Storey15	65.212	53.72	50.541	52.047	54.072
Storey16	66.223	55.557	52.035	53.605	55.668

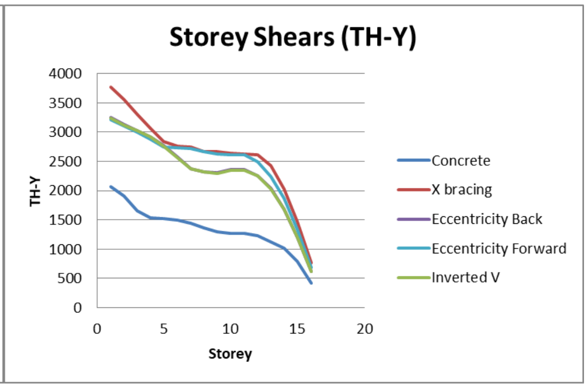




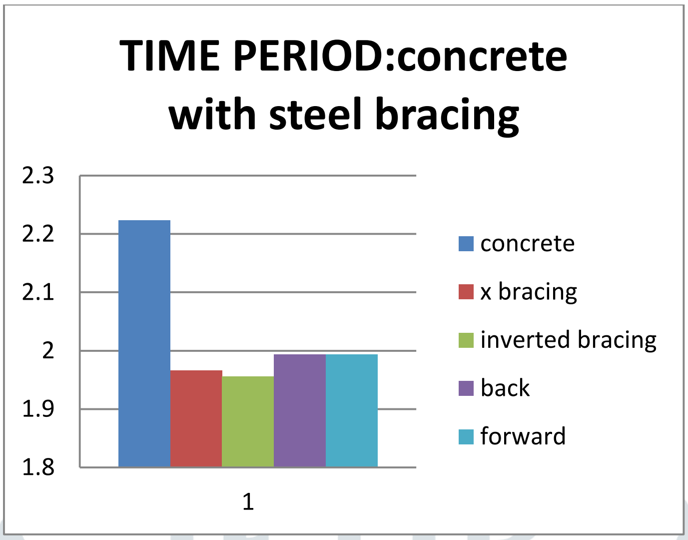
Storey Shears					
Storey	TH-X				
	Concrete	X bracing	Inverted V	Eccentricity Back	Eccentricity Forward
Storey1	3284.2314	4846.5857	5115.8847	5105.2512	5088.4535
Storey2	3223.6616	4708.5724	4848.6694	4838.0853	4884.343
Storey3	3127.039	4514.5663	4487.9907	4477.4415	4671.3392
Storey4	2995.1127	4269.0516	4117.7654	4104.8648	4424.0669
Storey5	2820.3602	3972.8677	3816.6405	3804.029	4121.6252
Storey6	2601.0699	3639.9831	3487.0608	3475.9491	3761.0438
Storey7	2343.3538	3304.4351	3116.7697	3107.3263	3353.549
Storey8	2207.152	3020.8114	2715.1873	2707.126	2929.2276
Storey9	2094.9376	2808.4069	2305.0784	2297.2322	2567.6879
Storey10	1945.0378	2575.9802	2180.1587	2177.9471	2344.8565
Storey11	1787.5199	2391.4367	2092.6276	2086.8356	2341.8469
Storey12	1691.0854	2285.5293	2056.9711	2052.0896	2269.4692
Storey13	1600.5821	2066.9327	1908.0469	1904.0079	2074.636
Storey14	1387.623	1720.5886	1617.3216	1614.318	1739.9198
Storey15	1027.2272	1243.5799	1180.2087	1178.3297	1262.0129
Storey16	535.6057	644.9802	614.1418	613.2314	654.2761

Storey Shears					
Storey	TH-Y				
	Concrete	X bracing	Inverted V	Eccentricity Back	Eccentricity Forward
Storey1	2067.3515	3763.4829	3239.7596	3248.1129	3215.8059
Storey2	1902.7438	3551.0541	3122.0557	3130.0872	3105.3138
Storey3	1650.3497	3308.8307	3018.9422	3026.3515	2997.4282
Storey4	1534.0812	3070.2953	2912.084	2918.9277	2876.1406
Storey5	1515.1252	2835.7525	2763.201	2769.4815	2747.7272
Storey6	1490.8231	2764.6074	2562.418	2568.2031	2728.0152
Storey7	1437.2872	2748.4597	2371.6799	2377.348	2717.8302
Storey8	1360.0952	2666.5405	2317.3751	2323.2344	2659.9565
Storey9	1288.9539	2665.2979	2296.8796	2302.8085	2627.8052
Storey10	1271.129	2634.6182	2350.4808	2356.2977	2612.0849
Storey11	1268.4751	2628.2901	2350.4911	2356.1415	2606.4542
Storey12	1234.138	2609.2456	2251.2185	2256.5336	2488.1475
Storey13	1128.1004	2423.6883	2030.2717	2034.9964	2244.5348
Storey14	1015.22	2023.6581	1678.9515	1682.8117	1861.0442
Storey15	787.7062	1464.5332	1202.0136	1204.7456	1337.1706
Storey16	422.9486	760.2656	616.9451	618.3312	688.5923





TIME PERIOD: Concrete with steel bracing					
Mode	concrete	x bracing	inverted bracing	back	forward
1	2.223	1.966	1.956	1.993	1.993



CONCLUSION:

- The storey displacement for the concrete structure is noted to decreases with the use of bracings.
- By observing the storey displacements for concrete bracing, it is observed that Inverted-V has less storey displacement than other bracings.
- The Base Shear for concrete structure is increased highly by using different types of bracings(50%).
- The base shear for concrete structure is effective for Inverted-V than other bracings.
- Time period for concrete structure is less for inverted v bracings so it is economical.
- The storey displacement for the steel structure is noted to decreases more than the concrete structure with the use of bracings..
- Therefore, it is conclude that inverted-V is effective because having less storey displacements and storey shears, base shear increases, time period decreases for normal bracings for concrete structure.

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