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## Research Article

# SEISMIC ANALYSIS OF BRACED RCC AND STEEL STRUCTURES USING ETABS SOFTWARE

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### ABSTRACT

Steel braced frame is one of the structural systems used to resist earthquake loads in multistoried buildings. Many existing reinforced concrete buildings need retrofit to overcome deficiencies to resist seismic loads. The use of steel bracing systems for strengthening or retrofitting seismically inadequate reinforced concrete frames is a viable solution for enhancing earthquake resistance. Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. In the present study, the seismic study of conventional x brace, zipper brace and SBS in RCC and steel structures using ETABS software is investigated. The bracing is provided at each corner. A G+6, G+12 and G+18 story with 6 bay in x direction and 3 bay in y direction is analyzed using ETABS. The effectiveness of various types of steel bracing is examined. The effect of the distribution of the steel bracing along the height of the RCC structure on the seismic performance of the rehabilitated building is studied. Provision of conventional x braced, zipper braced and SBS is provided in each stories. The percentage reduction in lateral displacement is found out. It is found that deformation and base shear is lower for SBS with double spring bracings in case of RCC structures but for the steel structures, deformation value is lower for zipper braced frame and base shear value is lower for SBS with double spring bracing.

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## INTRODUCTION

Steel framed construction is a new concept in which Lateral loads are better resisted by bracings. Buckling in braces can be restrained by ZIPPER AND STRONG BACK SYSTEM(SBS). The main advantages of braces are higher strength, Stiffness, economy, occupies less space and less weight. Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity.

- Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure.
- A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity.
- Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength.

Static and dynamic analysis is done using ETABS 2016 software.

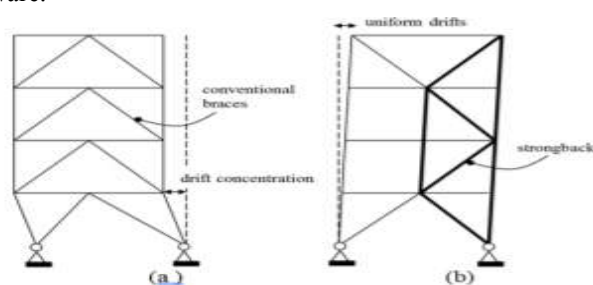


Figure 1 conventional and SBS bracing

## METHODOLOGY

Modeling of G+6 story steel and RCC structure providing;

1. Without bracing (WB)
2. With x bracing (XB)
3. With zipper bracing(ZB)
4. With SBS (1. Typical double-story X (DS X))

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1. Intermittent chevron (IC)
2. 3. Shifted double-story X (S DS X)
3. 4. Tied-to-ground with single spring (SS)
4. 5. Tied-to-ground with double spring (DS)

Modeling of G+12 story steel and RCC structure providing;

1. With zipper bracing (ZB)
2. Tied-to-ground with double spring (DS)
3. With x bracing (XB)

Modeling of G+18 story steel and RCC structure providing;

1. With zipper bracing (ZB)
2. Tied-to-ground with double spring (DS)
3. With x bracing (XB)

Static and dynamic analysis of steel and RCC structures.

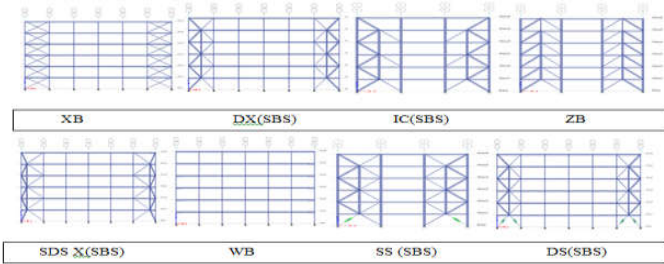


Figure 1 Eight different models of RCC and steel structures for G+6 storey provided with their names are shown

Material and section properties of steel structures

Story level	Column schedule		Beam schedule		Bracing schedule		
	Number	Size	Number	Size	Number	Size	
G+6	C1	ISMB 300	B1	ISMB 250	BR1	ISA 150x115x15	
G+10	C2	ISMB 400	B2	ISMB 350	BR2	ISA 150x150x15	
G+12	C1	ISMB 300	B1	ISMB 250	BR1	ISA 150x115x15	
G+10	C2	ISMB 400	B2	ISMB 350	BR2	ISA 150x150x15	
G+18	10-18	C1	ISMB 300	B1	ISMB 250	BR1	ISA 150x115x15

Material and section properties of RCC structures

Story level	Column schedule		Beam schedule		Bracing schedule	
	Number	Size	Number	Size	Number	Size
G+6	C1	350x350	B1	250x350	BR1	ISA 150x115x15
G+12	C2	400x500	B2	300x400	BR2	ISA 150x150x15
G+18	C3	450x550	B3	350x450	BR2 BR1	ISA 150x150x15 ISA 150x115x15

## EXPERIMENTAL RESULT

Table 1 G+6 Storey RCC Structures

G+6 STOREY RCC STRUCTURES					
SNO	MODELS	DISPLACEMENT(mm)		BASE SHEAR (kN)	
		X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION
1	D X	10.508	10.55	1114.65	1113.29
2	IC	9.38	9.26	1005.79	998.46
3	ZB	9.51	9.538	1156.19	1154.15
4	SDS X	9.50	9.414	1017.44	1014.99
5	XB	10.408	10.44	1047.501	1046.99
6	WB	16.208	17.27	409.980	399.700
7	SS	8.96	8.45	1014.88	1007.87
8	DS	7.64	7.65	792.715	789.92

Table 2 G+6 Storey Steel Structures

G+6 STOREY STEEL STRUCTURES																	
SI NO	MOD ELS	MODAL ANALYSIS		STATIC EARTHQUAKE ANALYSIS				TIME HISTORY ANALYSIS( EL CENTRO EARTHQUAKE)				RESPONSE SPECTRUM ANALYSIS					
		TIME PERIOD (seconds)		BASE SHEAR (kN)		STORY DISPLACEMENT (mm)		TIME PERIOD(sec)		BASE SHEAR (kN)		STORY DISPLACEMENT(m)					
		X DIRECTI ON	Y DIRECTI ON	X DIRECTI ON	Y DIRECTI ON	X DIRECTI ON	Y DIRECTI ON	X DIRECTI ON	Y DIRECTI ON	X DIRECTI ON	Y DIRECTI ON	X DIRECTI ON	Y DIRECTI ON				
1	DS X	0.854	0.77	787.662 1	873.679 1	14.079	12.407	5.9	3.1	708.874	786.3	11.09	8.85	708.836	786.364	10.638	10.557
2	IC	0.958	0.842	701.627 3	798.094 3	15.562	13.342	4.3	5.8	630.891	718.18	10.393	11.35	630.854	718.19	11.773	11.768
3	ZB	0.802	0.733	839.585 4	918.779 4	13.309	11.882	2.4	3.1	680.04	744.25	5.69	7.31	755.6	826.925	10.08	9.799
4	SDS X	0.918	0.819	733.334 9	822.208 9	14.86	12.878	4.3	5.7	594.022	665.95	8.77	7.81	660.035	739.98	11.137	11.18
5	X B	0.92	0.822	731.358 7	818.403 7	15.148	13.185	4.3	5.8	592.42	662.91	8.83	10.13	658.233	736.59	11.31	11.39
6	W B	7.392	2.292	166.754 7	291.041 9	154.221	28.017	2.6	6.5	138.67	235.71	116.11	17.73	150.107	261.939	119.726	120.054
7	SS	0.904	0.828	744.356 8	812.406 7	14.312	12.689	4.3	6.6	669.89	731.16	8.58	9.1	669.939	731.18	10.655	10.652
8	DS	1.148	1.03	586.087 3	653.962 6	15.634	13.8	5.5	4.4	472.39	587.77	11.72	10.03	527.426	525.58	11.717	11.67

## CONCLUSIONS

- The double spring SBS bracing with increased stiffness were found to be excellent seismic control device for controlling forced responses such as base shear, roof displacement and storey drift for lower rise, medium rise and high rise steel structures.
- The deformation value for SBS DS of RCC structure is reduced by 26.59% compared to X bracings and the base shear value for the same is reduced by 24.32% compared to X bracing.
- The deformation value for zipper bracing of steel structure is reduced by 35.56% compared to X bracings and the base shear value for SBS DS is reduced by 11.04% compared to X bracing.
- Value of drift as per IS 1893:2002 should not be greater than 0.004 times the storey height which is within the limit.
- In case of RCC structures, as the height increases, the storey deformation is increasing and base shear is decreasing.
- In case of steel structures, as the height increases both the deformation and base shear is decreasing
- As the stiffness is increased, soft storey effect is minimized and also the displacement is reduced.
- So it is better option for providing SBS with double spring bracings to high rise buildings for RCC and steel structures.

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