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Research Article

SEISMIC ANALYSIS OF BRACED STEEL AND COMPOSITE STRUCTURES USING ETABS SOFTWARE

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A R T I C L E I N F O

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A B S T R A C T

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 steel and composite 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 structures 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 for the steel and composite 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.

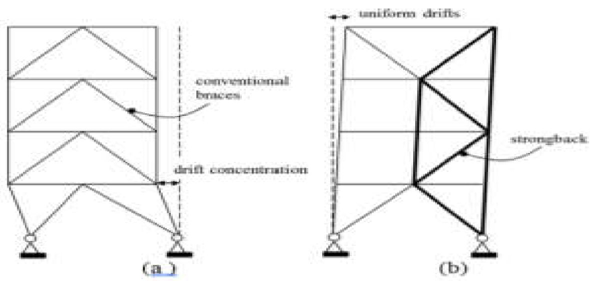

Figure 1 Conventional and SBS bracing

METHODOLOGY

Modeling of G+6 story steel and composite 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)

Intermittent chevron (IC)

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

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Modeling of G+12 story steel and composite 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 composite 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 composite structures.

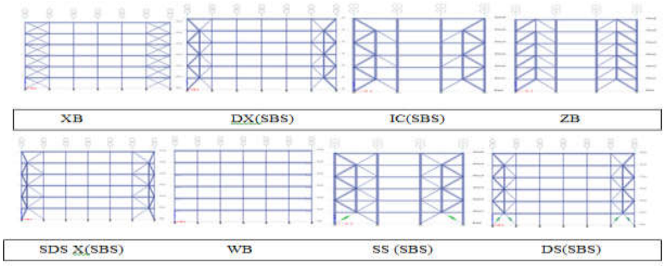

Figure 1 Eight different models of composite and steel structures for G+6 storey provided with their names are shown

Table 1 Sectional 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+12	G+10	C2	ISMB 400	B2	ISMB 350	BR2	ISA 150x150x15
	10-12	C1	ISMB 300	B1	ISMB 250	BR1	ISA 150x115x15
G+18	G+10	C2	ISMB 400	B2	ISMB 350	BR2	ISA 150x150x15
	10-18	C1	ISMB 300	B1	ISMB 250	BR1	ISA 150x115x15

Table 2 Sectional Properties of Composite Structures

Story level	Column schedule		Beam schedule		Bracing schedule	
	Number	Size	Number	Size	Number	Size
G+6	C1	300x300mm with embedded ISHB 200	B1	ISMB 200	BR1	ISA 150x115x15
G+12	C2	350X350mm with embedded ISHB 250	B2	ISMB 250	BR2	ISA 150x150x15
					BR1	ISA 150x115x15
G+18	C3	400X400mm with embedded ISHB 300	B3	ISMB 300	BR2	ISA 150x150x15
					BR1	ISA 150x115x15

EXPERIMENTAL RESULT

Table 3 G+6 storey COMPOSITE structures

G+6 STOREY COMPOSITE STRUCTURES							
SNO	MODELS	DISPLACEMENT(mm)		BASE SHEAR (kN)		TIME PERIOD(seconds)	
		X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION
1	D X	6.63	6.69	1331.76	1025.74	0.637	0.626
2	IC	8.95	11.08	687.75	797.422	0.771	0.761
3	ZB	7.71	8.11	1286.39	1350.36	0.601	0.599
4	SDS X	11.46	9.29	689.51	739.911	0.918	0.819
5	XB	9.74	9.73	875.89	875.68	0.715	0.715
6	WB	26.06	29.08	269.16	263.07	2.361	2.308
7	SS	9.039	11.205	916.60	874.49	0.732	0.698
8	DS	8.792	8.73	670.83	673.88	0.952	0.948

Table 2 G+6 Storey Steel Structures

G+6 STORY STEEL STRUCTURES																	
SI NO	MODELS	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(mm)		BASE SHEAR (kN)		STORY DISPLACEMENT(mm)	
		X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION	X DIRECTION	Y DIRECTION
1	DS X	0.854	0.77	787.6621	873.6798	14.079	12.407	5.9	3.1	708.874	786.3	11.03	8.85	708.836	786.364	10.638	10.557
2	IC	0.958	0.842	701.6273	798.094	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	839.5854	918.7795	13.309	11.882	2.4	3.1	680.04	744.25	5.69	7.31	755.6	826.925	10.08	9.7593
4	SDS X	0.918	0.819	733.3349	822.2089	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	731.3587	818.4036	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	166.7547	291.0419	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	744.3568	812.4062	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	586.0873	653.0626	15.634	13.8	5.9	4.4	527.39	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 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.
- The deformation value for zipper bracing of composite structure is reduced by 17.86% compared to X bracings and the base shear value for SBS DS is reduced by 23.42% 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 steel and composite 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 composite and steel structure and also zipper bracing for lower storey structures.

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