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Seismic Analysis of Steel Braced Reinforced Concrete Multi-Storey Frame

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Abstract: *The steel bracing system is one of the effective measures for resisting horizontal force like earthquake force or may be wind force which act on the multi-storey building. When steel bracings are use in building they are subjected to tension or compression and steel preferred section can withstand these force can be used. As the steel bracing is used in the building structure they induce stiffness and strength to building structure which helps to reduce their deformation. The present study is focused on the G+10 building when subjected to seismic force with and without steel bracing. In this study the ISLB 225 steel beam section is used as a bracing in the building. The different types of bracing formation are used like X, V- type and Inverted V are modeled by using ETAB software and result of these models are compared with each other as well as with bare frame model. It has been found that the use of steel bracing system can be very helpful to reduce displacement of structure, but the X type braced frame model shows less value among the entire braced frame.*
Keywords: *Bracings, Steel beam, Seismic force, ETAB, X type bracing*.

I. Introduction

The earthquake is the unpredicted phenomenon which occurs due to movement of tectonic plates under the earth surface. Whenever earthquake occurs that leads to collapse of structure. The damage made in high rise structure is irreversible and may cause the loss of life. So it is very important that the structure should resist the seismic force to that extent at least life can be saved. There are many techniques available which found very helpful for resisting excess displacement and reduce the effect of seismic force on the structure. The use of steel bracing can be the alternative. There are many types of bracing systems which can be used like X, V, Inverted V, Diagonal etc. these bracings can be made by using concrete or steel, but the use of steel bracing is more convenient then construction of concrete bracing.

The steel braced is one of the structure used to face up earthquake masses in multistorey building. It is widely observed that building structure which are not design as per earthquake resisting guidelines they are more at risk of collapse under seismic force. The use of steel bracing in this type of building can provide resistance against it.

II. Literature Review

Faced with identity theft and document fraud, with more new threats such as cybercrime or terrorism, and be faced with the understandable changes in the international regulations, new technological solutions are mostly being implemented. One of these technologies, biometrics, has been quickly established itself as the most pertinent means of identifying and authenticating with individuals in a fast and in the reliable way, through the usage of unique biological characteristics. Today, many applications were adapted for using this technology. That which in the past was reserved for the sensitive applications such as the security of the military sites is now developing rapidly through the more applications in the public domains.

M.A. Youssef et.al. In this paper they author has taken the comparison between the ductile frame and normal frame with X type bracing. The frame have a size of 12 x 12m with 3 bays in x and y direction. The frame has four storey with floor to floor height of 3m each. After the analysis and design they have concluded that the use of Braced RC frame is found more promising against lateral force.

A. Massumi et.al. In this paper they have studied the behaviour of low ductile reinforced concrete frames, which found week against the lateral force. Now this frame is strengthened by using steel X – Bracings with different details. The five different types of bracing connection is used, where two frames has a connection made by using bolts. One frame with two plates and bolt and another with single plate only. The rest of the three frames are made connection with cover angles which are welded. The all frames are tested under cyclic loading. After the performing different test they have concluded that the use of bracing with bolted connection can be used for medium rise building. And the use of bracing with angle found more energy absorbent.

Vani Prasad et.al. They have observed that when an existing RC frame is bracing with steel bracings the strength of the frame is increased, along with decreasing displacement of frame. In this paper the existing multi storey building is modelled in sap2000 and the force required is calculated. After that the different modelled is prepared to know the best performing model. Building frame is modelled with shear wall, another with different bracing system. The time history analysis is performed on the models. After the analysis they have concluded that use of bracing in concentric or eccentric manners helps to reduce displacement and increase the lateral stability of structure. But they have also stated that the use of eccentric bracing can be the best alternative with respect to concentric bracing.

Bhosle Ashwini Tanaji et.al. In this paper author has studied the different frames having different bracing type like Diagonal, Inverted V, V type, X type and K type. They have provided the bracing in parallel manner by the sides. The thirteen storey building is analysed under seismic condition. The earthquake zone is III as per IS 1893:2002. The models is analysed by using ETAB Software. They have concluded that the base shear is increased by 60% - 65% when concrete X - bracing is used. The use of X type bracing gives the more resistance against the overturning.

Viswanath K.G et.al. In this paper the author have analysed the structure with steel bracing under seismic loading of zone IV. The different models which has different bracing type is analysed by using STAAD Pro software. The bracing types are used as Diagonal, X type and K type. The structure is modelled with three different storey as 8, 12 and 16. After the analysis they have concluded that the use of X type of bracing in building structure the displacement is limited. They have also concluded that the use of steel bracing can be the better alternative for strengthen and retrofitting of existing structure.

III. Modelling & Analysis

All the models are made and analysed as by using ETAB software. The G+10 storey structure is prepared. There are four different types of model is prepared.

Sr. no	Model
1	Bare frame
2	Frame + X type bracing
3	Frame + V type bracing
4	Frame + Inverted Bracing

Table no. 1 Model information

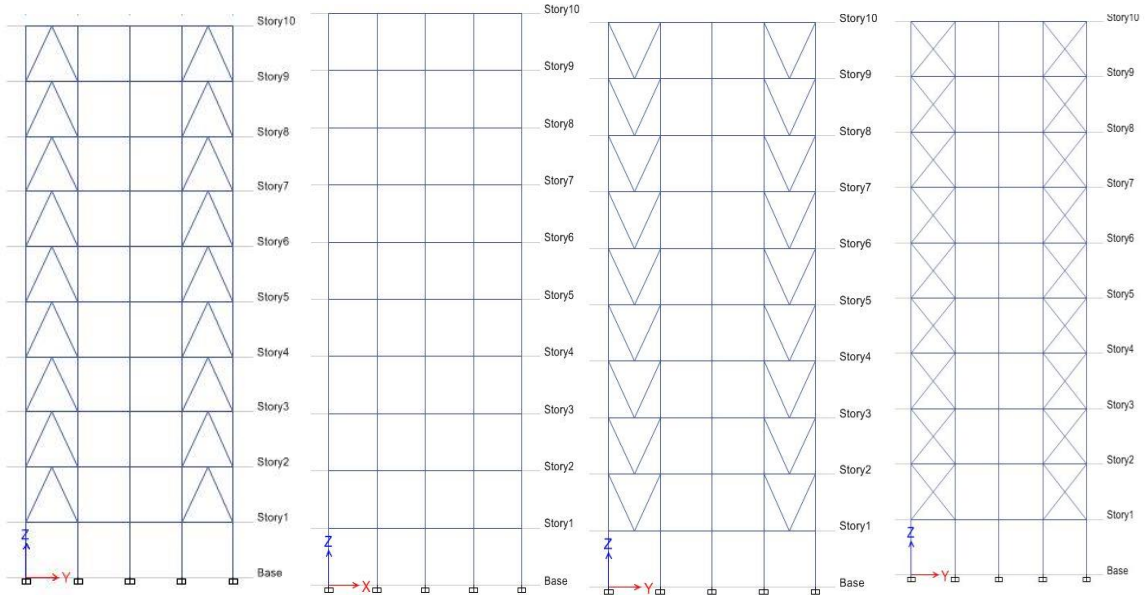


Fig (a) Fig (b) Fig (c) Fig (d)

Fig. no. 1 (a) Frame with Inverted bracing, (b) Frame without bracing (bare frame) (c) Frame with V - type bracing (d) Frame with X type bracing.

The following table contains the necessary data required for analysis of structure,

PARAMETERS	**DIMENSIONS**
SIZE OF BEAM	250 X 300 MM
SIZE OF COLUMN	250 X 350 MM
GEOMETRY PARAMETER	
STOREY HT.	3 M
SPACING OF COL.	3M
DEPTH OF FOUNDATION	3 M
BAY ALONG X-DIR.	4
BAY ALONG Z - DIR	4
SIZE OF BUILDING	12 X 12 M
LOADING ON STRUCTURE	
LIVE LOAD	3 KN/M^2
SLAB	120 MM
THICKNESS OF INTERNAL WALL	230 MM
THICKNESS OF EX. WALL	230 MM
PARA. WALL HT.	1.5M
DENSITHY OF CONCRETE	25 KN/M^2
DENSITY OF BRICK	20 KN/M^2
EARTHQUAKE PARAMETER (IS 1893:2002)	
ZONE	IV
SOIL TYPE	MEDIUM SOIL
IMPORTANCE FACTOR	1.5
STRUCTURE TYPE	CONCRETE STRUCTURE
SUPPORT TYPE	FIXED TYPE
LOAD COMBINATIONS	
LOAD COMBINATION	1.5 (DL+LL) 1.2(DL+LL+ EQ) 1.2(DL+LL - EQ) 1.5(DL+_EQ) 1.5(DL - EQ) 0.9DL+ 1.5EQ 0.9DL - 1.5EQ
STEEL BRACING	
ISLB 225	h = 225MM tw =8.6 MM tf = 5.8 MM bf = 100 MM

Table no. 2 parameters for design

IS 1893: 2002 gives the guidelines for Earthquake Resistance design.
As per Clause mention(6. 4. 2), the design horizontal seismic coefficient (A_h)

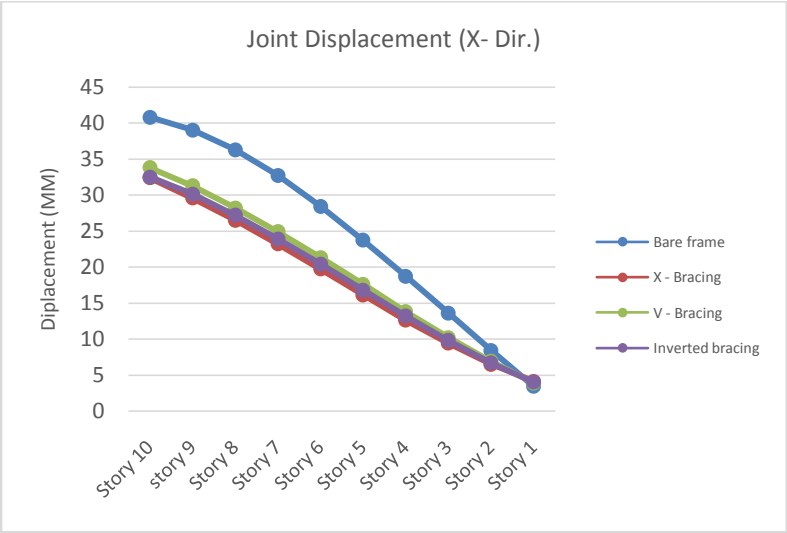
$$A_h = \frac{Z}{2}\frac{I}{R}\frac{Sa}{g}$$

Where,
Z = Zone factor
I = Importance Factor
R = Response Reduction factor
Sa/g = Average Response acceleration coefficient

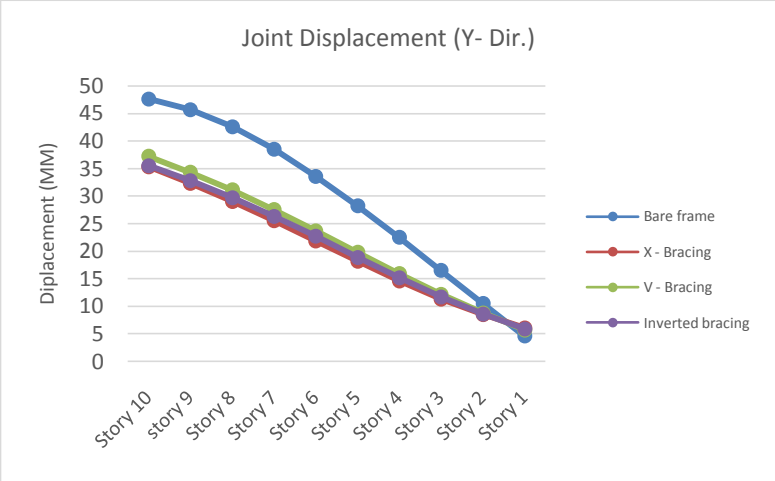
As per IS 1893:2002 the zone of earthquake in India is divided in four zones as follows, (Clause 6. 4. 2, Table 2, Pg. 16) and Zone IV has value as 0.24.

The importance factor of the building considered as 1.5. The Response Reduction Factor (R) as Per IS1893:2002 mention in Clause (6. 4. 2, Table No.7) for Special moment resisting frame is R = 5.

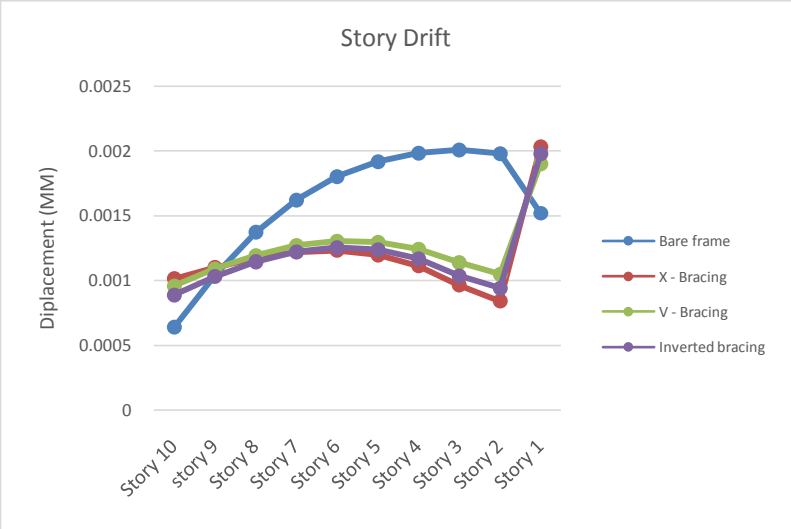
Every model of G+10 multistorey with different types of bracing type is analysed and results are reported. This paper cover the effect of displacement behaviours of structure under seismic force with and without bracing. The result of joint displacement and storey drift are compare in graph and conclusions are drawn.



Graph no. 1 shows joint displacement in X – direction



Graph no. 2 shows joint displacement in Y – direction



Graph no. 3 Shows storey drift

Frequency (Cycle/sec.)				
Mode	**Bare frame**	**X - Bracing**	**V - Bracing**	**Inverted bracing**
1	0.699	1.022	0.955	0.996
2	0.828	1.142	1.069	1.112
3	0.885	1.605	1.474	1.537
4	2.115	3.127	2.961	2.982
5	2.527	3.635	3.401	3.42
6	2.68	4.78	4.468	4.544
7	3.605	6.661	5.855	5.903
8	4.38	7.3	6.514	6.541
9	4.55	9.833	8.921	8.996
10	5.089	9.859	9.192	9.289
11	6.297	9.885	9.737	9.795
12	6.487	9.914	11.885	11.942

Tableno. 3 Shows mode frequency

Period (Seconds)				
Mode	**Bare frame**	**X - Bracing**	**V - Bracing**	**Inverted bracing**
1	1.43	0.979	1.047	1.004
2	1.208	0.875	0.936	0.899
3	1.13	0.623	0.678	0.651
4	0.473	0.32	0.338	0.335
5	0.396	0.275	0.294	0.292
6	0.373	0.209	0.224	0.22
7	0.277	0.15	0.171	0.169
8	0.228	0.137	0.154	0.153
9	0.22	0.102	0.112	0.111
10	0.197	0.101	0.109	0.108
11	0.159	0.101	0.103	0.102
12	0.154	0.101	0.084	0.084

Tableno. 4 Shows mode time period

IV. Conclusion

After the analysis of the structure it found that the use of steel bracing in the structure can be the effective alternative to reduce the excess displacement of structure.

It is also found that the use of bracing also effect the time period and frequency of structure. After the analysis following conclusions are made and they are as follows,

1. The joint displacement in both the direction is reduced when steel bracings are used. The results are found more effective when X type of bracing is used. The reduction in the joint displacement of structure when compare with bare frame model is about 20 – 30 % w.r.t all the floors.
2. The storey drift of all the braced model is less as compared to bare frame model but the X - type bracing model shows less storey drift w.r.t. to all the braced model. The reduction in the storey drift in model with X - type bracing is about 20-30% w.r.t. all the floors.
3. It is also observed that braced frames has higher frequency then bare frame. But the frame which is braced with X type of bracing has much higher frequency for every mode.
4. The time period of the braced frame is reduced w.r.t. to bare frame model. The lowest value of time period is observed for frame with x type of bracing for every mode.

The use of steel bracing can be the effective alternative for reducing the adverse effect on the structure resulting from seismic action.

V. Conclusion

Biometrics is the automated recognition of an individual is based on their behavioral and biological characteristics. It is a tool for establishing the confidence and that one is dealing with the individuals who are already known (or not known) and consequently that they can belong to a group with a certain rights (or to a group to be denied certain privileges). It relies on the presumption of that individuals are physically and behaviorally distinctive in a number of ways.

Biometric systems are been used as increasingly to recognize the individuals and regulate the access to physical spaces, information, services, and to the other rights or benefits, including the ability to cross the international borders. The motivations for using the biometrics are diverse and often to a overlap. They can include improving the convenience and efficiency of routine access transactions, reducing fraud, and enhancing the public safety and the national security.

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