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RESEARCH ARTICLE OPEN ACCESS

Comparison of Conventional Brace and Buckling Restrained Brace in Steel Frame Structure

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ABSTRACT
A conventional moment resisting steel frame undertakes large level of lateral deformation when subjected to strong ground motion or wind forces. If this deformation is excessive, structural and non-structural damage is evident, which damages structural integrity. To avoid such large deformations, various types of systems have been used in steel frames. Diagonal elements, called braces, have been implemented as additional structural member that increase the stiffness and energy dissipation, and control relative inter story deformation in an effective way, thus protecting the structure against damage and improving the overall behavior. The BRBs permits very high compression strength. Because there is no reduction in the available material strength due to instability, the brace can achieve great ductility..

Keywords - Lateral load resisting systems, Buckling Restrained Brace, Conventional Braced frame, concentrically braced frame, specially concentric braced frame

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I. INTRODUCTION

Horizontal loads such as seismic or wind loads brings a crucial view in design of high rising or tall structures. Since from many decades, several design techniques and construction methodologies have been evolved, focusing to improve the lateral load resisting capacity of tall structures.

1.1 A traditional moment resisting steel structure undergoes huge amount of deformation in horizontal direction when exposed to wind forces or strong earthquake ground motion. The damage in structural and non-structural members of a structure is obvious if the horizontal deformation is excessive, and hence the structural integrity is damaged. In order to control such substantial deformations, different classes of supporting systems are utilized in high rising steel structures. The diagonal bracing members are executed as a supplementary member of a structure, which improves the strength, rigidity and energy dispersal of whole system. These supplementary devices also controls the relative inter story drifts in a successful way, hence securing the structure to counteract the damage going to produce and enhance the overall performance of structure.

1.2 advantages of brb-
Buckling-restrained type of bracing members (BRBs) does not reveal any unfriendly performance of conventional braces. They are having fully balanced hysteretic conduct with yielding in compression exactly similar to yielding in tension. This performance is achieved through the decoupling of the flexural-buckling resistance and stress resistance aspects of compressive strength in bracing member. Since the inner core of steel is restricted from clasping or buckling, an even axial stress is developed across the section. Formation of plastic hinges in bracing members associated with buckling can be avoided by proper design and detailing OF BRBS. VERY HIGH COMPRESSIVE strength is contributed by BRBs. Since there is zero loss in the strength of materials available due to insecurity, the effective longitudinal dimension of the bracing member can be assumed equal to zero. By appropriating inelastic properties to yield the inner steel core axially, great ductility can be achieved.

1.3 Motivation of present work - Since the growth is population is increasing every year and land area to accommodate this population is constant, we engineers have no any other option than to construct high rising structures. These high rising slender structures becomes significant while considering the effect of seismic loading on them. These high rising structures are more susceptible to failure of complete structure or great horizontal distortion because of strong earthquake shaking and requires some outstanding detailing work to restrict the failure or large displacements. This failure or large displacements may be restricted to a certain limit by making provision of ductility or flexibility in the steel structure. Hence we restrict this horizontal displacement, by several engineering techniques can be employed. Different type of conventional bracing systems are as effective method to control lateral load carrying capacity of high rise buildings but these Conventional bracing members have little deforming and flexibility capacity.

1.4 Aims and objectives of the present work-

1.To observe experimentally the effect of ordinary braces in steel frame having slenderness ratio more than 90 under the action of lateral load

2. To compare the frame behavior with buckling restrained braces using the same brace but placed in hollow tube to restrain its buckling

3.To arrive at measure of effectiveness of buckling restrained braces under different lateral loading on different frames such as frame with ordinary brace and frame with buckling restrained brace for two, three numbers of bays.

Indentations and Equations

MATERIALS AND METHODS

Following methodology will be adopted for proposed research work;

A) Literature Survey:

This will be through journals, proceedings, reference books, technical magazines &moreover through Internet for latest available literature

B) In this project we will do

1.Analysis and Design of frame model using STADD pro software

2. Experimental setup

After the Analysis and Design of frame model using STADD pro software. We Create the Frame Using the Dimension. This Frame Fitted with Using the Bolted Connection on the ‘I’ Section (C.I.).This are fitted with the ground floor in concrete.

3. Loading arrangement

4. Number of test

5. Result

6. Conclusion

7. References

Figures and Tables

For the STADD analysis the model of steel frame two bay and two story with storey height and bay width equal with lateral load acting at each story level as shown in fig. 4.1 is taken. The sections of frame and braces are so finalize that, when loaded the braces should fail first and then frame members.

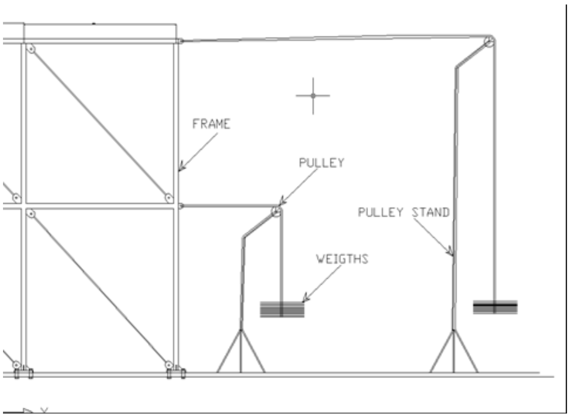

Figure 1.1 Proposed Loading Arrangement

Figure 1.2 Actual Loading Arrangement

Following fig.1.3 shows the failed members when loaded with static lateral load

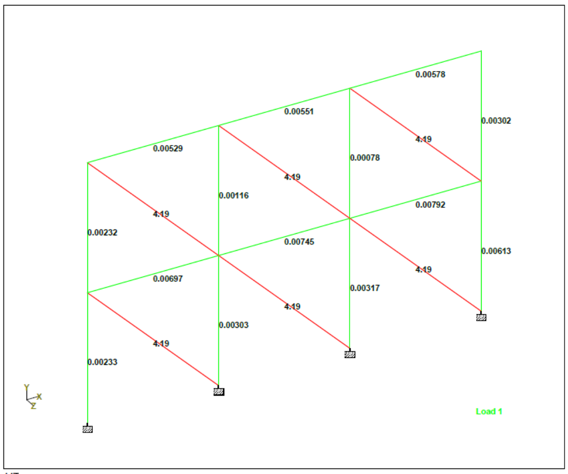

fig.1.3 Failed members when loaded with static lateral load.

Following Figure 1.4 Utility Ratio and Failed Members

Table 1.1 Utility Ratio

Utilization Ratio

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
1	TUB25252.6	TUB25252.6	0.007	1.000	0.007	IS-7.1.2	1	2.160	1.720	1.720	3.040
2	TUB25252.6	TUB25252.6	0.007	1.000	0.007	IS-7.1.2	1	2.160	1.720	1.720	3.040
3	TUB25252.6	TUB25252.6	0.008	1.000	0.008	IS-7.1.2	1	2.160	1.720	1.720	3.040
4	TUB25252.6	TUB25252.6	0.005	1.000	0.005	IS-7.1.2	1	2.160	1.720	1.720	3.040
5	TUB25252.6	TUB25252.6	0.006	1.000	0.006	IS-7.1.2	1	2.160	1.720	1.720	3.040
6	TUB25252.6	TUB25252.6	0.006	1.000	0.006	IS-7.1.2	1	2.160	1.720	1.720	3.040
7	TUB25252.6	TUB25252.6	0.002	1.000	0.002	IS-7.1.2	1	2.160	1.720	1.720	3.040
8	TUB25252.6	TUB25252.6	0.003	1.000	0.003	IS-7.1.1(A)	1	2.160	1.720	1.720	3.040
9	TUB25252.6	TUB25252.6	0.003	1.000	0.003	IS-7.1.1(A)	1	2.160	1.720	1.720	3.040
10	TUB25252.6	TUB25252.6	0.006	1.000	0.006	IS-7.1.1(A)	1	2.160	1.720	1.720	3.040
11	TUB25252.6	TUB25252.6	0.002	1.000	0.002	IS-7.1.2	1	2.160	1.720	1.720	3.040
12	TUB25252.6	TUB25252.6	0.001	1.000	0.001	IS-7.1.1(A)	1	2.160	1.720	1.720	3.040
13	TUB25252.6	TUB25252.6	0.001	1.000	0.001	IS-7.1.1(A)	1	2.160	1.720	1.720	3.040
14	TUB25252.6	TUB25252.6	0.003	1.000	0.003	IS-7.1.1(A)	1	2.160	1.720	1.720	3.040

Table 1.2 Failed Member

Failed Members

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
15	Cir 0.01	Cir 0.01	4.190	1.000	4.190	SLENDERNE	1	0.283	0.006	0.006	0.013
16	Cir 0.01	Cir 0.01	4.190	1.000	4.190	SLENDERNE	1	0.283	0.006	0.006	0.013
17	Cir 0.01	Cir 0.01	4.190	1.000	4.190	SLENDERNE	1	0.283	0.006	0.006	0.013
18	Cir 0.01	Cir 0.01	4.190	1.000	4.190	SLENDERNE	1	0.283	0.006	0.006	0.013
19	Cir 0.01	Cir 0.01	4.190	1.000	4.190	SLENDERNE	1	0.283	0.006	0.006	0.013
20	Cir 0.01	Cir 0.01	4.190	1.000	4.190	SLENDERNE	1	0.283	0.006	0.006	0.013

From the above analysis finalized sections of frame and brace are
Column – 25x25x2.6 Rectangular Tube
Beam – 25x25x2.6 Rectangular Tube
Conventional Brace – 6mm dia. Circular bar.
Buckling Restrained Brace – 6mm dia. Bar surrounded by circular pipe.

Fig. 1.5Conventional Brace

Frame with three bay-
In this test a frame with two bays is tested under different lateral load with the following condition i.e. Frame with conventional brace and Frame with buckling restrained brace. The lateral load applied at the top is half the load applied at bottom storey.
The test results obtained are as following

CBF-
Table1.3 Applied load vs. storey deflection for CBF

	Applied Load	Storey	Deflection
Load Case-1	5	TOP	0.69
	10	BOTTOM	0.42
Load Case-2	10	TOP	2.35
	20	BOTTOM	0.89
Load Case-3	15	TOP	2.75
	30	BOTTOM	1.45
Load Case-4	20	TOP	4.62
	40	BOTTOM	1.90
Load Case-5	25	TOP	4.98
	50	BOTTOM	2.55

Following fig.1.6 shows the graphical presentation of load vs. deflection for top and bottom storey

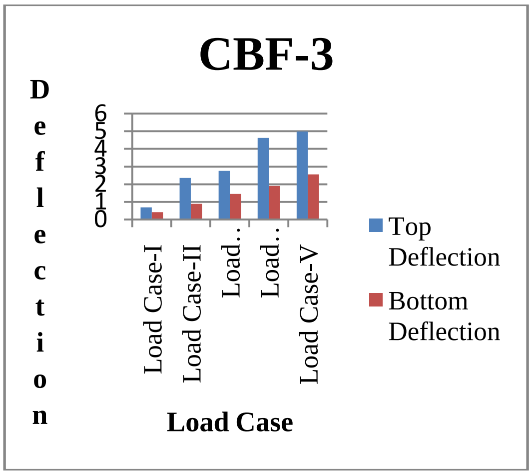

Figure 1.6 Load Case vs. Deflection for CBF-3

Fig.1.7 Three bays frame with conventional brace.

BRBF

Table 1.4 Applied load vs. storey deflection for BRBF

	Applied Load(Kg)	Storey	Deflection(mm)
Load case-1	5	TOP	0.45
	10	BOTTOM	0.1
Load case-2	10	TOP	1.72
	20	BOTTOM	0.79
Load case-3	15	TOP	2.22
	30	BOTTOM	1.08
Load case-4	20	TOP	2.96
	40	BOTTOM	1.78
Load case-5	25	TOP	3.91
	50	BOTTOM	1.92

Following fig.1.8 shows the graphical presentation of load vs. Deflection for top and bottom storey Figure.

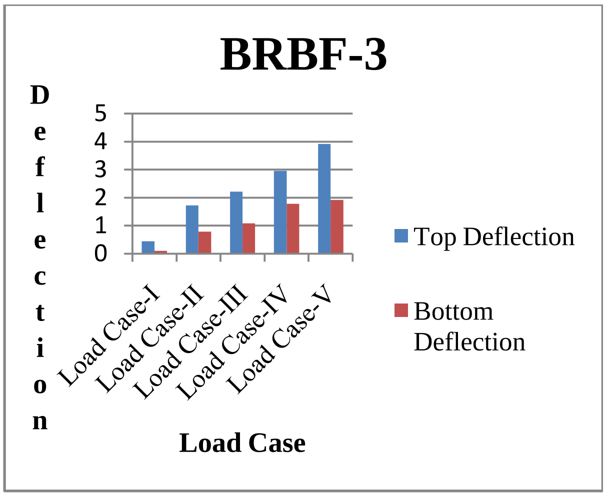

Figure.1.8 Load vs. Deflection for CBF Figure Load vs. Deflection for BRBF

Fig.1.9 Three bays frame with buckling restrained brace

II. RESULT

The three bay two storey steel frame was tested under three different boundary conditions i.e. Un-braced frame (frame without bracing), steel frame with conventional bracing system and a steel frame with buckling restrained bracing members. The steel frame without any bracing subjected to horizontal loads of 25 and 50 kg at top and bottom storey respectively, have secured the maximum deflection at top storey of 5.75 mm and at bottom storey it was found to be 3.52 mm. The ordinary conventionally/traditional bracing members in steel frame, received the greatest deflection at top storey of 4.987 mm and at bottom storey it was 2.55 mm for the similar loads as stated above. And finally, the steel frame configured with buckling restrained bracing members secure the maximum deflection of just 3.91 mm at the top storey and 1.91 mm at the bottom storey for same horizontal loads

Figure 1.10 gives the comparing statement of load carrying capability and maximum displacement of top storey with different configurations of bracing systems.

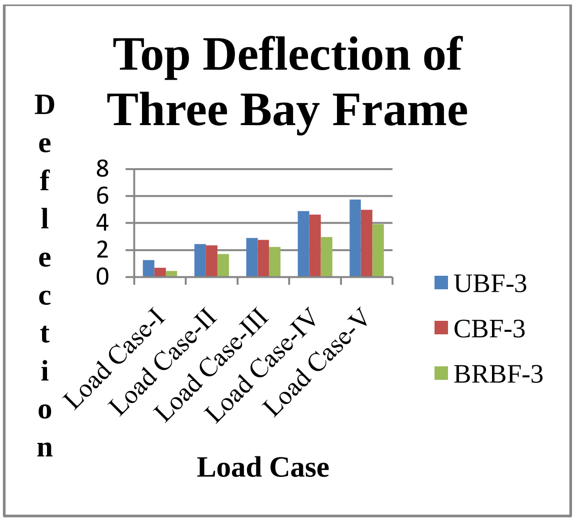

Fig. 1.10 Relationship between Load Case and the deflection of Top Storey for three bay steel frame.

Figure 1.11 gives the comparative statement of load carrying capability and maximum displacement of bottom storey with different configurations of bracing systems

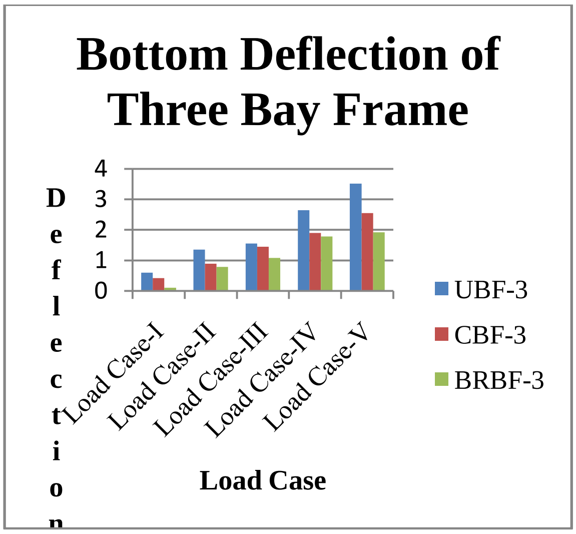

Fig. 1.11 Relationship between Load Case and the deflection of bottom Storey for three bay steel frame

The steel frame without bracing secured the mean displacement of 3.44 mm at the top storey and 1.93 mm at the bottom storey. The conventionally supported frames with bracing members received the mean displacement of 3.07 mm at the top storey and 1.44 mm at the bottom storey. And finally the steel frame configured with buckling restricted bracing members received least displacement of 2.25 mm at the top storey and 1.13 mm at the bottom storey.

Figure 1.12 gives the comparing statement of maximum displacement at different storey levels with different configurations of bracing systems

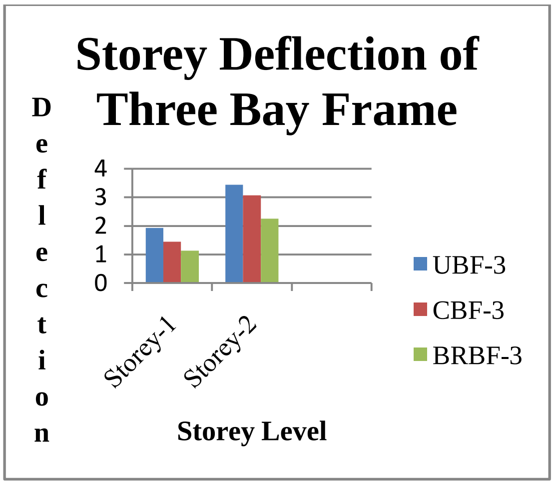

Fig. 1.12 Relation between storey deflection and storey levels for three bay steel frame

III. CONCLUSION

From the results obtained, the following conclusion shall be written to evaluate the effectiveness of BRB to increase the lateral load caring capacity of frame (i.e. three bays) frames are tested and then tested.

1. The storey Deflection of all steel frames subjected to horizontal load was found to be 25% less in buckling restrained steel frame in comparison with steel frame with conventional braces, by utilizing the braces of same cross sectional area.
2. In three bay two storey steel frame, the mean ratio of lateral storey deflection in conventionally braced steel frame to buckling restricted steel frame is 1.33. Hence, it is clear that, the horizontal load carrying capacity of Buckling Restrained Bracing members is higher than that of conventional braces.
3. BRB likewise gives the practically cost effectiveness in horizontal load opposing system when contrasted with ordinary conventional bracing members.

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