DESIGN AND DEVELOPMENT OF BUCKLING RESTRAINED BRACES USING MATLAB.

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***Abstract*— Earthquake forces on structure are of great concern to the engineers. To minimize the effects of an earthquake and lateral loads, the steel braced frames are used. It is one of the systems which plays an effective role in resisting the lateral loads the new type of bracing system called buckling restrained braces are introduced to overcome the drawbacks of conventional bracing system.**

The project work is to study buckling restrained braces. The analysis is done using MATLAB. In the present study, a code for a building model is developed to analyze the behaviour of the structure without BRB. Response spectrum analysis method is used to determine the linear dynamic response of the structure. The response parameters such as Base Shear, Story displacement, Time period, Inter-story drift are evaluated to study the structural performance. The same model results are validated in ETABS v16. Further, a code will be developed for a building structure with BRB to compare the response of both structures.

***Keywords**: Buckling restrained brace, Base shear, Displacement, MATLAB, Time-period*

I. INTRODUCTION

There are various technologies and equipment's which are used for the construction of a structure. Despite these technologies, a structure may be influenced by an earthquake. Ultimately leading to loss of property and human life in the area where an earthquake has occurred. Thus, it has become essential for engineers to consider the earthquake effect and to construct a structure to resist earthquake forces Earthquake implies lateral load on the structure which effects on the performance of the building tending to go under large displacement and storey drift which leads to the failure of some of the structural elements and eventual collapse of the structure. To avoid this collapse and loss of property a proper lateral load resisting system has to be designed for required load demand capacity.

A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both in tension and compression.

Buckling-restrained braces (BRBs), which were first applied in 1989 in Japan, are now widely used worldwide as ductile seismic-proof members in seismic zones. Buckling Restrain Braced frame is a new and effective type of lateral load resisting system to increase the ductile seismic performance of the building. It is designed to allow the building to withstand cyclic lateral loadings, typically induced due to earthquake one. If the BRBF designed carefully it provides an advantage to a system by which the inherent ductility of mild steel can be translated into system ductility which thereby controls the seismic response of the structure to a harmful earthquake and presents an effective alternative to conventionally braced frames. BRBF have more ductility and energy absorption than SCBF because overall brace buckling, and its associated strength degradation, is precluded at forces and deformations corresponding to the design story drift.

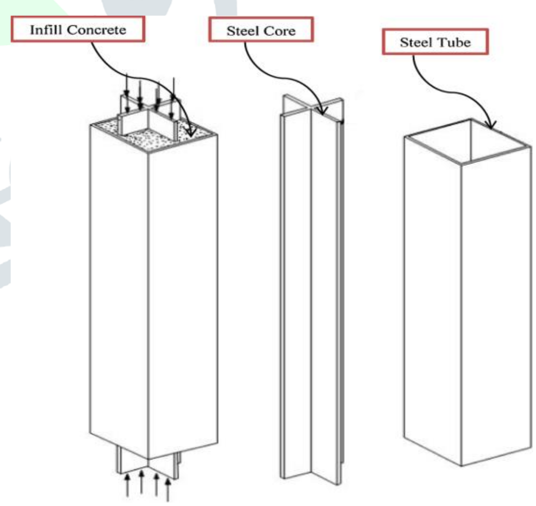


Fig 1. Components of BRB

Three major components of a BRB can be distinguished are its steel core, its bond-preventing layer, and its casing

The steel core is designed to resist the full axial force developed in the bracing. Its cross-sectional area can be significantly lower than that of regular braces since its performance is not limited by buckling. The core consists of a middle length that is designed to yield inelastically in the event of a design-level earthquake; and rigid, non-yielding lengths on both ends. The increased cross-sectional area of the non-yielding section ensures that it remains elastic, and thus plasticity is concentrated in the middle part of the steel core. Such configuration provides high confidence in the prediction of the element behaviour and failure.

The objective of this study is to study different approaches to design Buckling restrained Braces, develop a code to perform seismic analysis of a structure and compare the behaviour of structure with and without BRB.

II. RESEARCH METHODOLOGY

The analysis of seismic response of a G+6 for validation purpose and G+10 storied building is done using MATLAB which gives the output in form of Time period, Frequency, Mode Shapes, Displacement, Base Shear, Storey Shear, Intra story Drift, etc. The structure was designed and checked for serviceability. The input requirements are seismic weight and lateral stiffness of each floor of the structure. The demand for lateral load was calculated by time history analysis by newmarks modified method.

A. *Seismic analysis of Building-*

The MDOF system is analysed using Modal analysis. The equation of motion for MDOF system is given by:

$$[m]\{\ddot{u}(t)\} + [c]\{\dot{u}(t)\} + [k]\{u(t)\} = -[m]\{r\}\ddot{u}_g(t) \quad \ldots(1)$$

where,

[m]= Mass matrix (n x n);

[k] =Stiffness matrix (n x n);

[e] =Damping matrix (X):

{r}=Influence coefficient vector (nx1);

Normalizing the uncoupled equation (1) by expressing the mass matrix [m] and expressing in terms of damping ratio ξ and frequency ω it can be written as,

$$\ddot{u}(t) + 2\xi\omega_i\dot{u}(t) + \omega_i^2 u(t) = -\Gamma\, \ddot{u}_g(t) \quad \ldots(2)$$

Mode shapes, Frequency, Displacements, etc for undamped system are obtained by using the equation:

$$|[k]-w^2[m]| = 0$$

Where,

k = Stiffness of floor

m= Mass on Each floor

w= Natural frequency

B. *Design of Buckling Restrained Brace.*

The story shear from each floor is used for the demand for design of BRB.

$$Area_{brb} = \frac{Pu * Cos^2\theta}{\phi * Fysc}$$

Where,

Pu = Storey shear.

θ = Angle of brace with respect to x-axis

Φ = 0.9, Strength reduction factor.

Stiffness of provided BRB is found out as K_{br} =A*E/L

C. *Modelling*

A G+10 storey RC frame with 4 bays is considered for analysis without buckling restrained braces. The Frame has 4 bays of 5m. The storey height is 3m for all floors. The seismic analysis is done by time history analysis by applying El Centro ground motion data.

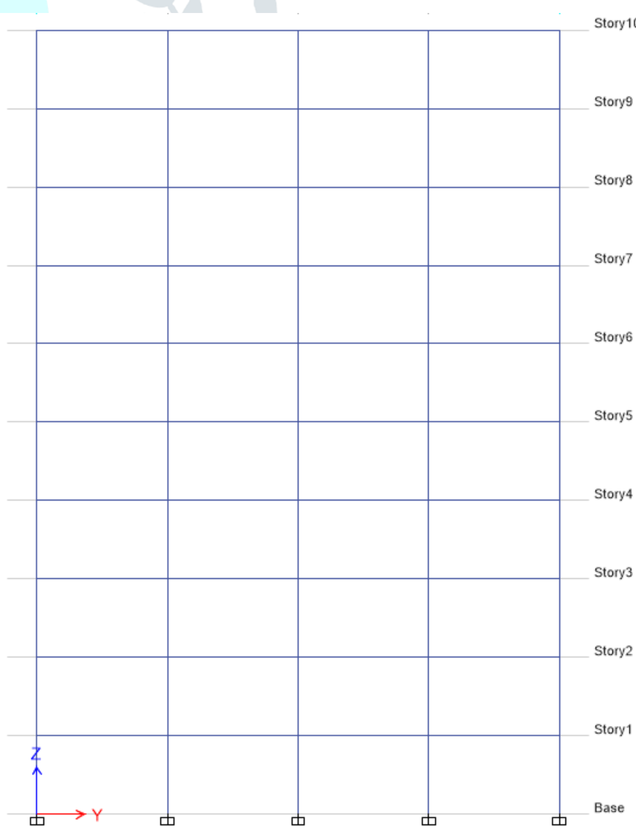


Fig 2. Elevation of structure.

TABLE 1.
MATERIAL PROPERTIES AND SECTION DETAILS

Parameter	ETABS	Newmark
Maximum displacement At the top floor	42mm	46mm
Time Period	0.480sec	0.539sec

For validation, a code for G+6 storey building is developed in MATLAB and the results are compared with a similar model in ETABS. Seismic response results of the structure obtained from both software are follows

TABLE 2.

Parameter	*Value*
Grade of Concrete Used	M25
Elastic Modulus of Concrete	25000 Mpa
Unit Weight of concrete	25 kN/m^3
Lateral Stiffness of each floor	33092.22 kN/m
Seismic Mass of each Floor	72843 Kg
Damping Ratio	2%
Size of columns	230 x 450 mm
Size of beams	230 x 400 mm
Response Spectra Data	El Centro

III. RESULTS

A. Base Shear

Application of buckling restrained braces showed a considerable decrease in base shear of building the results are as below.

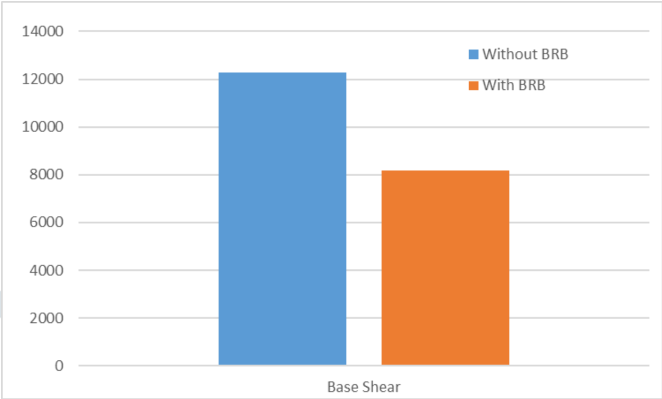
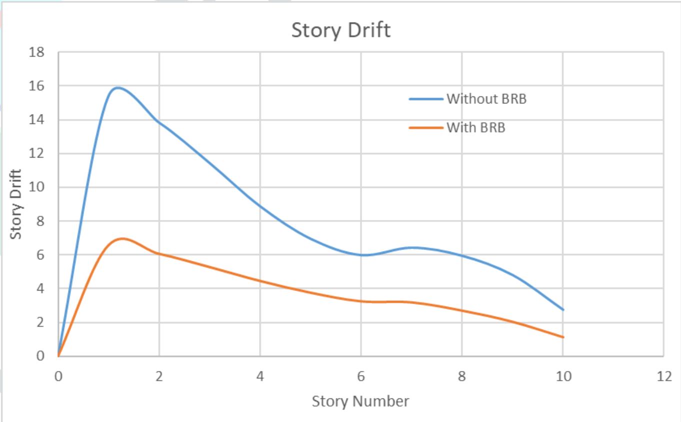


Fig 2. Elevation of structure.

B. Story Drift

Installation of BRB shows a considerable amount of reduction in inter-story drift. The maximum observed reduction was 42%.



IV CONCLUSION

In this study of RC building with and without BRB the seismic performance was observed as follow

- After the application of there was a reduction of 33% in the base shear
- The inter story drift was decreased by 42%.

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