International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Comparative Analysis of Concenrically Braced Frame, Eccentrically Braced Frame and Moment Resisting Frame of Steel

Man Mohan Singh

[1]Student at Ganga Institute of Technology and Management, MDU, Kablalna, Jhajjar

Abstract: ***In framed structure, most commonly used system to resist seismic forces are concentrically braced, eccentrically braced and moment resisting frames. This study shows the behavior of these frames and also describes their seismic requirement for the purpose of design making. For the study three frames of 3, 6 and 9 storey are assumed. The comparative study is done for different zones as per Indian code of practice IS 800:2007 and IS 1893(Part -1):2002 are used for loading conditions and STAAD PRO V8i software is used for analysis of frames.***

Keywords: Frames, Bracing, Staad Pro, Seismic.

1. Introduction

The action which is applied on a structure during an earthquake is generally ground movement with vertical and horizontal components. The lateral component of the earthquake is the most specific quality of an earthquake action due to its strength and also because of this structure is generally designed to resist gravity than horizontal forces. The vertical component of the earthquake is generally about 50% of the horizontal component, but except in the vicinity of the epicenter of the earthquake where it can be usually of the same order. Experience shows that steel frame structures subjected to earthquakes behave well. Structural failures and large numbers of casualties are mostly associated with structures made from other materials. This may be expressed by some of the specific features of steel structures. There are mainly two means by which the earthquake may be resisted:

Option 1: structures of sufficiently larger sections that they are subject to only elastic stresses. Option 2: structures of smaller sections, designed to form numerous plastic zones.

A structure designed to according to the first option will be heavier and may not provide a safety margin to cover earthquake actions that are higher than expected, as element failure is not ductile. In a structure designed to the second option selected parts of the structure are intentionally designed to undergo cyclic plastic deformations without failure, and the building as a whole is designed such that only those selected zones will be plastically deformed.

2. Literature Review

2.1 Sabelli, R., Mahin, S., & Chang C. (2003)

Some results which are described in this journal from a research being done to identify following parameters:

- Structural and material characteristics.
- Ground motion that generally controls the response of earthquake in concentrically braced steel frames.
- To recognize improved design measures and provisions of codes.

The main focus of this journal is on the seismic response of 3 and 6 storey structures with concentric braces with the use of buckling-restrained braces. A short research is also provided in the journal about the properties and the benefits of their use in the frames. This thorough nonlinear dynamic analyses is done for the precise cases as well as statistically analysis for some suites of ground motions which describes the outcome on the basic response parameters of different structural proportions and configurations.

2.2 Faggiano, B., Della Corte, G., Mazzolani, F. M., & Landolfo, R. (2005).

A fire which follows the earthquakes is generally considered one main threat in various seismic regions. In fact, modern seismic codes suggests that regular structures which are designed to experience damage to some level during powerful earthquakes, exploits the structures own ductility to keep away from collapse and defend human being lives.Then, a fire approaching soon after an earthquake will discover a different, more weak, structure with deference to the initial, unspoiled, one. Thus depending on the amount of damage, the fire resistance evaluation of the structure might be considerably reduced.

This journal is devoted to obtain some quantitative data on this topic, for the steel moment-resisting frames, even if the assumed methodology could also be extensive to either diverse structural types or structural resources. As a first step, a basic modeling of earthquake-induced structural harm, based on these superposition of mechanical and geometrical effects, is proposed. Then, a large numerical analysis is done with reference to a single-bay 1-storey frame structure, permitting the main parameters disturbing the problem to be identified.

2.3 Okazaki, T., Arce, G., Ryu, H. C., & Engelhardt, M. D. (2005).

In this journal 23 tests were executed to study the reversal loading performance of the seismic links in eccentric braced steel frames. The main aims of these tests were:

- To re-evaluate over strength parameters,

- Flange slenderness ratio limits for the links.

The outcome of the loading on the seismic link performance was also checked. Seismic link specimens were constructed with the five different wide-flange sections, all of them are designed ASTM A992 steel, with changed lengths ranging from small shear links to long flexural links.

This also gives data on the various effects of flange buckling and overstrength, in these tests some unpredicted failure modes are also shown. The journal also provides an overview about the experimental study, which describes the overall study program, and also the details of the specimens and results. This journal also includes a no. of design recommendations advised for the seismic links in the eccentrically braced frames.

2.4 Özhendekci, D., & Özhendekci, N. (2012).

It is shown in this paper that arrangement of span is a critical parameter for the perspective of the designer, so it in straight affects the economy and seismic performance of the design. But, previous study has not given sufficient interest to the valuation of its effects. So three different 10-story special moment resisting steel frames with having different span actions are designed in such a way to the provisions of Turkish seismic design codes which having similar allowable capacity design and stress design procedures which are available in AISC Manual and Seismic procedures for Steel Buildings. With the given geometric properties & design earthquake load, a constant seismic effective mass is kept for frames which was assumed to be
suitable for evaluation purposes.

3. Analysis

3.1 Preliminary Data

For the comparison of three types of basic steel seismic resistant structures moment resisting steel frames (MRF), steel frames with concentric bracings (CBF) & steel frames with eccentric bracings (EBF) according for the Indian conditions a general problem of a steel frame of following properties was selected:
Length of frame = 5 bay of 4m = 20.0m
Width of frame = 4 bay of 4m =16.0m
For this comparison, frames of three different
heights were selected which were as follows:
3 storeys of 3m = 9m
6 storeys of 3m = 18m
9 storeys of 3m = 27m

For moment resisting frames only beam-column frame was modelled, while in frames with concentric bracings X-bracings were introduced in the frame in both x and z directions. Along the length where 5 bays are present, X-bracing is provided at 2nd and 4th bay while along width, X-bracings are provided in 2nd and 3rd bay because there are only four bays present. In the frames with eccentric bracings (EBF) bracings are provided at the same positions as provided in the frames with concentric bracings but with some eccentricities. These bracing are similar to the inverted V-bracings but with some eccentricities are provided on the top beams to generate seismic links, which resists the lateral loads in these frames.

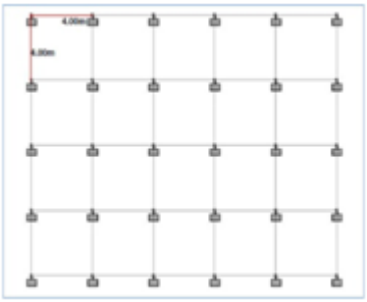

Figure 1: Model plan

4. Results

By doing analysis of these frames with the help of STAAD PRO software following results was determined. In the analysis of these structures optimization of the models was done with the help of code check process of the software. Optimization of frames gives the least possible value of the structure. These values are shown in following graphs:

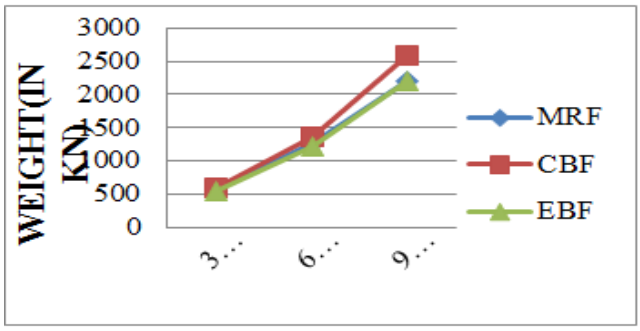

Figure 2: Weight Comparison for 3, 6 & 9 Storey (ZONE-II)

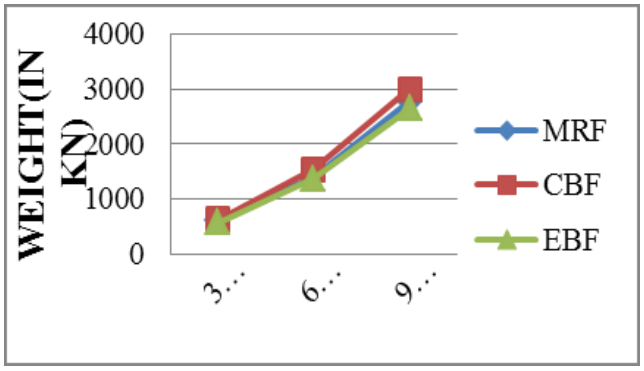

Figure 3: Weight Comparison for 3, 6 & 9 Storey (ZONE-III)

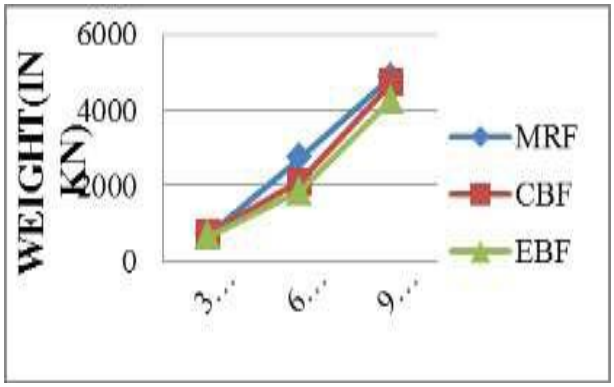

Figure 4: Weight Comparison for 3, 6 & 9 Storey (ZONE-V)

5. Conclusions

According to the results obtained from the analysis of these frames in which optimum steel sections were assigned to the frame at every member following conclusion can be made.

- For all four type of seismic zones least total weight of the structure is obtained in the eccentrically braced frames (EBF) for all three types of storey level frames.
- For 3 and 6 storey frame concentrically braced frames (CBF) shows maximum weight and for 9 storey frame Moment resisting frames (MRF) shows maximum weight for the structure.
- From the above discussion it can be concluded that for earthquake resistant structure eccentrically braced frames (EBF) are most economical type for any storey height.

6. Future Scope

- Models for the other type of bracing frames can be compared.
- Position of the bracings can be changed to see other efficient positions of them.
- Frames of other heights can also be checked for more precise results.

References

[1] Okazaki, T., Arce, G., Ryu, H. C., & Engelhardt, M. D. (2005). Experimental study of local buckling, overstrength, and fracture of links in eccentrically braced frames. Journal of Structural Engineering.

[2] Izadinia, M., Rahgozar, M. A., & Mohammadrezaei, O. (2012). Response modification factor for steel momentresisting frames by different pushover analysis methods. Journal of Constructional Steel Research, 79, 83-90.

[3] Özhendekci, D., & Özhendekci, N. (2012). Seismic performance of steel special moment resisting frames with different span arrangements. Journal of Constructional steel research, 72, 51-60.

[4] Malekpour, S., Ghaffarzadeh, H., & Dashti, F. (2011). Direct Displacement Based Design of Regular Steel Moment Resisting Frames. Procedia Engineering, 14, 3354-3361.

[5] Malekpour, S., Ghaffarzadeh, H., & Dashti, F. (2013). Direct displacement-based design of steel-braced

reinforced concrete frames. The Structural Design of Tall and Special Buildings, 22(18), 1422-1438.
[6] Rahmani, Z., Naghipour, M., Amiri, J. V., & Karimnezhad, R. (2013). Comparing Seismic Parameters in Dual Systems Equipped with Concentric and Eccentric Braces and Side Plate Connection. Middle-East Journal of Scientific Research, 14(3), 300-308.
[7] Metelli, G. (2013). Theoretical and experimental study on the cyclic behaviour of X braced steel frames. Engineering Structures, 46, 763-773.
[8] Tenchini, A., D'Aniello, M., Rebelo, C., Landolfo, R., da Silva, L. S., & Lima, L. (2014). Seismic performance of dual-steel moment resisting frames. Journal of Constructional Steel Research, 101, 437-454.

Author Profile

Mr. Man Mohan Singh received the B.Tech. degree in Civil Engineering from IPEC Ghaziabad affiliated to GBTU. He is now pursuing M.Tech. in Structural Design from GITAM, affiliated to MDU Rohtak. His area of interest is structural analysis and design.