Comparison of Moment Resisting, Concentrically Braced & Eccentrically Braced Steel Frames

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Abstract—Moment resisting frames, concentrically Braced frames & eccentrically braced frames are three most common seismic force resisting systems used in framed structure. These frames are comparatively effective as lateral force resisting system which is developed to resist seismic actions in a conventional manner. Appropriately detailed and designed seismic lateral force resisting frames behave in a ductile manner by the means of shear or flexural. This ductile yielding gives wide, excellent energy dissipation, balanced hysteresis loops, which is necessary for major lateral forces. This report shows the assessment of the behaviour of Moment resisting frames, concentrically braced frames & eccentrically braced frames and also describes their seismic response to different seismic conditions & parameters so that optimum weight of structure between these three for same seismic conditions can be determined.

Key words: Moment Resisting Frames, Concentrically Braced Frames, Eccentrically Braced Frames

I. 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. The vertical component of the earthquake is generally about 50% of the horizontal component, but except in the surrounding area of the epicentre 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. In a structure designed with lateral resistant devices some selected parts of the structure are intentionally designed to undergo cyclic plastic deformations without failure.

The variety of possible energy dissipation mechanisms in steel structures are moment resisting frames, concentrically Braced frames & eccentrically braced frames. But from these three mechanisms, optimum case for various conditions according to the local seismic properties described in the Indian codes should be selected. For this purpose this analysis is done and for that steel frame models of three different storey heights 3, 6 & 9 are used. According to four different zones described in IS 1893 (part I):2002, three type of lateral force resisting system frames are constructed using STAAD PRO v8i software. These models were then analysed and results were compared.

II. LITERATURE REVIEW


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

- Structural and material properties.
- 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.


C. 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 overstrength 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. Izadinia, M., Rahgozar, M. A., & Mohammadrezaei, O. (2012)

The earthquake forces which are imposed to the structures are generally much more than that what they are designed for. The reduction of design loads by seismic codes is through the application of (R-factor) response modification factor. During moderate to severe earthquakes, many structures usually behave in elastically due to which inelastic analysis is required for design. Inelastic dynamic analysis is very time consuming and interpretation of its results demands expertise of high level. Pushover analysis,
Currently commonly used, is however, a simple way of calculating inelastic response of structures.


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.

III. MODEL GENERATION

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 3.2m = 9.6m
6 storeys of 3.2m = 19.2m
9 storeys of 3.2m = 28.8m

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.

IV. RESULTS AND DISCUSSION

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:

![Graph 1: Weight Comparison for 3, 6 & 9 Storey (ZONE II)](image1)

![Graph 2: Weight Comparison for 3, 6 & 9 Storey (ZONE III)](image2)

![Graph 3: Weight Comparison for 3, 6 & 9 Storey (ZONE IV)](image3)

![Graph 4: Weight Comparison for 3, 6 & 9 Storey (ZONE V)](image4)

V. CONCLUSION & RECOMMENDATION

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.

VI. FUTURE SCOPE OF WORK

- 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


