Comparison of Seismic Analysis of Chevron Bracings in Regular and Irregular Buildings

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***Abstract*: The composite reinforced (RC) frame buildings are becoming most preferable for Earthquake Resistant Buildings. The composite materials that are used in composite RC frame buildings are Bracings, Struts, Shear walls, etc. These Composite RC frame buildings shows great stiffness and strength than normal RC frame buildings. Due to these advantages the composite structures are capable of resisting Earthquake effects. By the addition of bracing systems, load will be transferred out of the frame and passes on to the braces, by passing weak columns while increasing strength. The potential advantages of using steel bracing are their high strength, stiffness, economical, occupies less space and adds much less weight to the existing structure. This study is on Chevron bracing. The members used in Chevron bracing are designed for both tension and compression forces. This project is to compare the seismic analysis of chevron bracings in regular and irregular buildings by considering G+14 buildings with different plans. The response spectrum analysis is carrying out in this work.**

Keywords: Composite RC frame, Chevron bracing, G+14 buildings, ETABS software, response spectrum analysis

I. INTRODUCTION

Most of the multistoried buildings using today are made up of reinforced concrete framed buildings. A reinforced concrete building should be designed to have a capacity to carry combined loads (dead, live and seismic loads) at certain safety level and at certain degree of reliability.

The composite reinforced frame buildings are becoming most preferable for Earthquake Resistant Buildings. The composite materials that are used in composite RC frame buildings are Bracings, Struts, Shear walls, etc. These Composite RC frame buildings shows great stiffness and strength than normal RC frame buildings. Due to these advantages the composite structures are capable of resisting Earthquake effects. By the addition of bracing systems, load will be transferred out of the frame and passes on to the braces, by passing weak columns while increasing strength. The potential advantages of using steel bracing are their high strength, stiffness, economical, occupies less space and adds much less weight to the existing structure. By expanding its stiffness and stability steel bracings can enhance the resistance of structure against lateral forces. Chevron bracing are designed for both tension and compression forces. The members used in Chevron bracing are designed for both tension and compression forces. Chevron bracing members use two types of connections. The floor level connection may use a gusset plate much like the connection on X braced frames.

Fig 1: Chevron Bracing

II. OBJECTIVES

- To determine the seismic behavior of chevron bracing in regular buildings
- To determine the seismic behavior of chevron bracing in irregular buildings and also to identify the most effective among them
- To compare the seismic analysis of chevron bracings in regular and irregular building which shows better performance

III. LITERATURE VIEW

Robert Tremblay et al. (2001), described the seismic behaviour of chevron steel braced frames for 2, 4, 8, and 12-storey steel building structures. Two different design approaches were considered: one that corresponds to CSA-S16.1 seismic provisions for braced frames with nominal ductility with an R factor of 2.0, and one in which the beams are sized to develop a fraction of the yield tension capacity of the bracing members. In this second approach, an R factor of 3.0 was used for determining the seismic loads and chevron bracing with stronger beams capable of developing 100%, 80%, and 60% of the brace yield load were examined.

D.C. Rai et al. (2003), studied a building in the North Hollywood area, which suffered major damage in the 1994 Northridge earthquake. Response spectrum, nonlinear static (pushover), and nonlinear dynamic (time history) analyses for a ground motion recorded at a nearby site compared well with the observed damage.

Taichiro Okazaki et al. (2013), examined the dynamic response of a steel concentrically braced frame. The specimen was a single-bay, single-story frame with a

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pair of square hollow structural section braces placed in a chevron arrangement. The specimen response was reproduced by a numerical model using fiber elements. This model was able to predict the occurrence of brace buckling and fracture and thereby accurately trace the dynamic behavior of the frame.

P. Pramodkumar Reddy et al.(2015), studied the seismic performance of RC buildings with and without Chevron bracings and struts. Seismic analysis is performed on three models namely "G+14 Normal Building" as Model 1, "G+14 Building with Bracings" as Model 2, "G+14 Building with Single Struts" as Model 3 using Equivalent static method, Response Spectrum Method and Time History Analysis.

IV. METHODOLOGY

Methodology employed is response spectrum method

A. Modelling of Building

Here the study is carried out for the behaviour of G+14 storied R.C frame buildings in regular and irregular plans. Floor height provided as 3.4m. And also properties are defined for the frame structure. 7 models are created in ETABS software with chevron bracing. They are square, C shape, I shape, T shape, L shape, E shape and Plus shape buildings. The general software ETABS has been used for the modelling. It is more user friendly and versatile program that offers a wide scope of features like static and dynamic analysis, non- linear dynamic analysis and non-linear static pushover analysis, etc.

B. Building Plan and Dimensions

The regular and irregular buildings of plan area 400m^2 and height 3.4m is considered with G+14 storey in zone V. A medium soil stratum is considered at the location.

Table 1: Details and Dimension of the Building Models

Earthquake zone	V
Importance factor	1
Type of soil	Medium soil
Poisson's ratio	0.15
Density of RCC	25 kN/m^3
Thickness of slab	160mm
Depth of beam	380mm
Width of beam	300mm
Dimension of column	300mm X 450mm
Height of each floor	3.4m
Bracing used	ISA 110 x 110 x 10

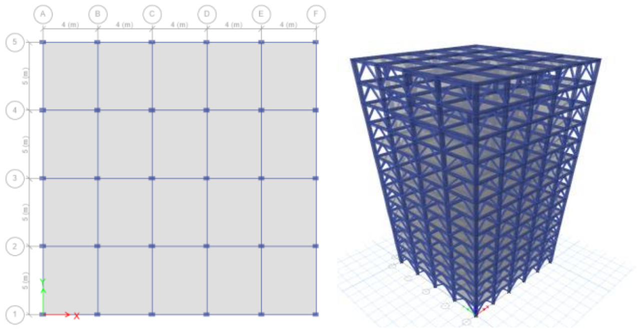

Fig.2: Plan and 3D view of regular building

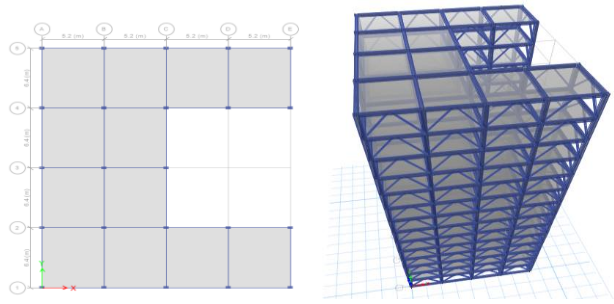

Fig.3: Plan and 3D view of C shaped building

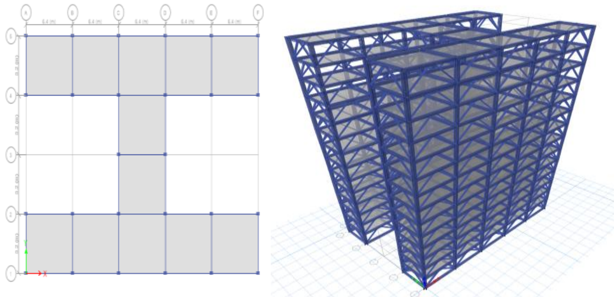

Fig.4: Plan and 3D view of I shaped building

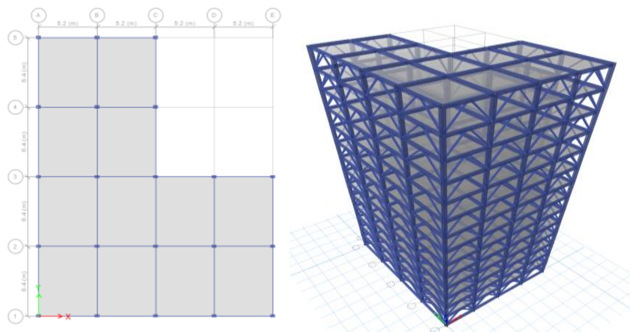

Fig.5: Plan and 3D view of L shaped building

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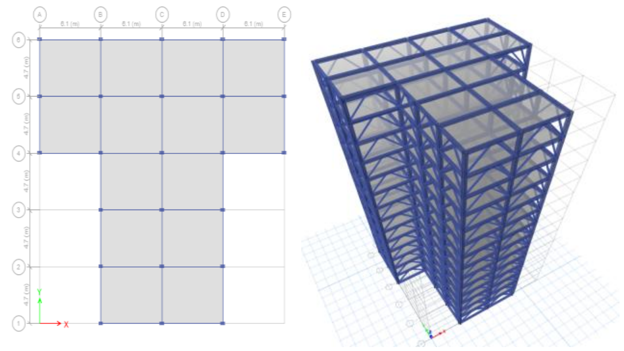

Fig.6: Plan and 3D view of T shaped building

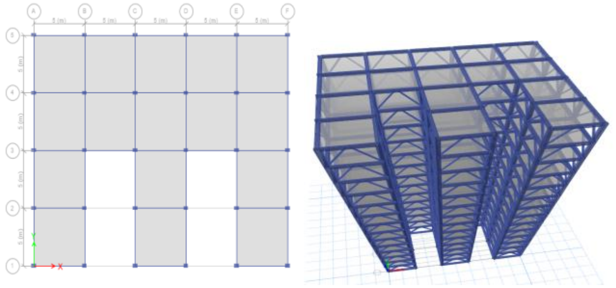

Fig.7: Plan and 3D view of E shaped building

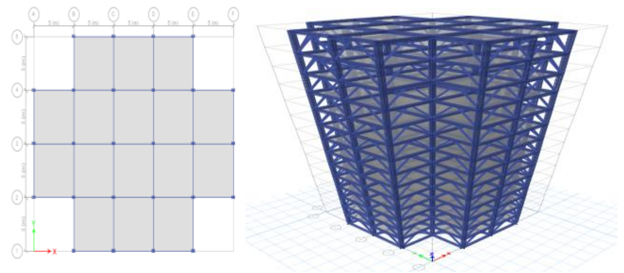

Fig.8: Plan and 3D view of Plus shaped building

C. Load Formulation

Loads are a primary consideration in any building design because they define the nature and magnitudes of hazards are external forces that a building must resist to provide a reasonable performance (i.e., safety and serviceability) throughout the structure's useful life.

Dead load

Dead load on each floor = 1.5 kN/m^2

Live load

Live load on intermediate floors = 4 kN/m^2

Live load on roof = 1.5 kN/m^2

Seismic load

Seismic loads are calculated as per IS: 1893 (Part 1)-2002.

V. COMPARISON OF RESULTS

After analysing the results obtained then it will be compared and find the seismic performance of the building frames.

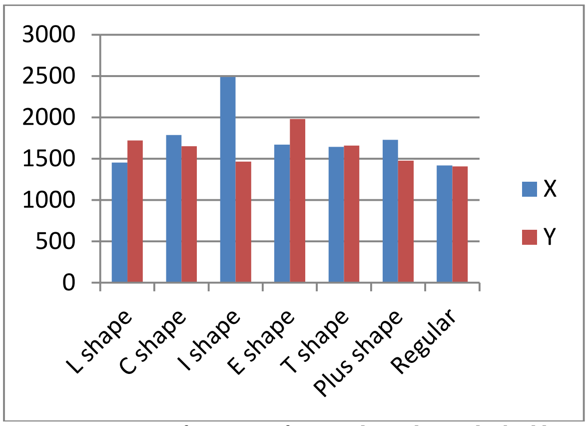

Fig.9: Comparison of Storey Drift in regular and irregular buildings

Fig.9 shows the maximum storey drift values of regular and irregular buildings under response spectrum in X and Y directions. The maximum storey drift value of regular building is less than that of irregular buildings in both X and Y directions . Therefore the regular building shows better performance than irregular building in maximum storey drift.

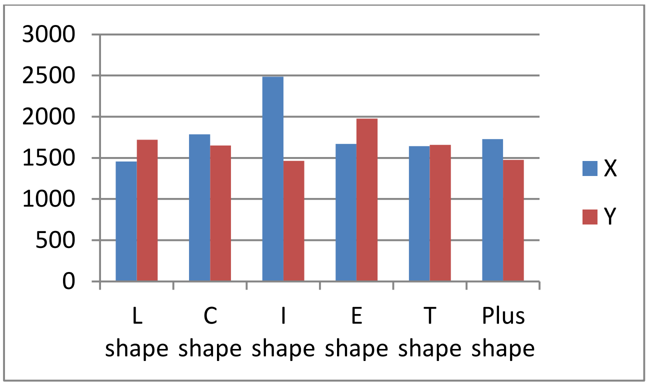

Fig.10: Maximum Storey Drift in irregular buildings

Fig.10 shows the maximum storey drift values of irregular buildings in X and Y directions. The storey drift in I shaped building is lesser than all other irregular buildings in X direction and also the storey drift in E shaped building is lesser in Y direction.

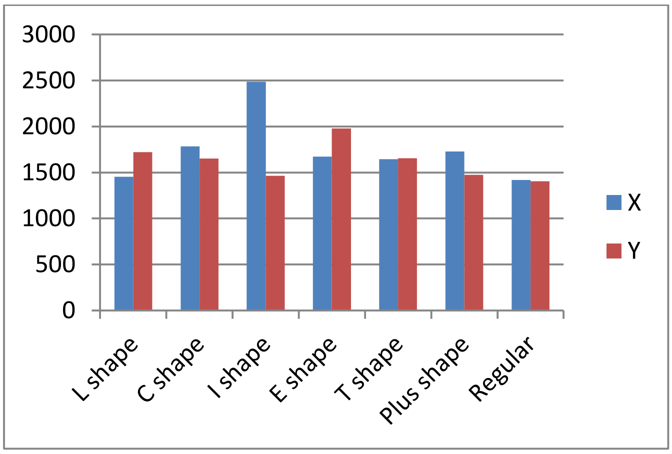

Fig.11: Comparison of Base Shear in regular and irregular buildings

Fig.11 shows the base shear in regular and irregular buildings under response spectrum analysis in X and Y directions. The base shear in regular building is lesser than irregular building and therefore the regular building is the better one.

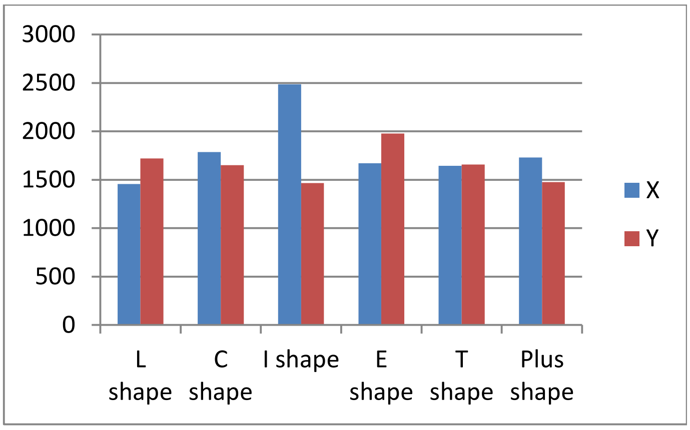

Fig.12: Base Shear in irregular buildings

Fig.12 shows the base shear values of irregular buildings in X and Y directions. The base shear in L shaped building is lesser than all other irregular buildings in X and the base shear in I shaped building is lesser in Y direction. Therefore L shaped building shows better performance in X direction and I shaped building is better in case of Y direction.

VI. CONCLUSIONS

In the present study, an attempt is made to study the seismic behavior of building with chevron bracing in regular and irregular buildings. First part of study included the dynamic analysis of building. The storey drift and base shear were obtained. The seismic analysis is carried out taking into consideration that all the buildings are located in zone V. The following are the conclusions obtained based on the analysis.

- The regular building with chevron bracing shows better performance than irregular building on the basis of maximum storey drift and base shear in both X and Y directions.ie; the regular building has lesser value of maximum storey drift and base shear
- On the basis of base shear L shaped building shows better performance in X direction and I shaped building shows better performance in Y direction than other irregular buildings
- On the basis of storey drift I shaped building shows better performance in X direction and E shaped building shows better performance in Y direction than all other irregular buildings
- The percentage reduction of base shear in regular building when compared to irregular buildings is 2.59% and 4.06% in X and Y direction respectively
- The percentage reduction of storey drift in regular building when compared to irregular buildings is 9.72% and 8.64% in X and Y direction respectively

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