The Study Of Mass Irregular Rc Structure With Various Arrengements Of Steel Bracings

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***Abstract*— From past earthquakes it is proved that many of structure are totally or partially damaged due to earthquake. So, it is necessary to determine seismic responses of such buildings. There are different techniques of seismic analysis of structure. Like Seismic Coefficient method, Response Spectrum method, Time History method etc. From this 'Response Spectrum analysis' is one of the important techniques for structural seismic analysis. Bracing system is one of the retrofitting techniques and it provides an excellent approach for strengthening and stiffening existing building for lateral forces. In this project work seismic analysis of 9 storey RCC buildings assumed to be situated at seismic zone IV as per the seismic zone map of India with mass irregularity at 3rd and 8th floor levels are carried out. Seismic analysis of RC building frames with X, V, Inverted V and Diagonal type bracing are done. ISHB 250 were utilized as bracing members. This paper highlights the effect of different lateral bracing system on mass irregular structure with 'Response Spectrum' analysis done by using ETABS software.**

***Keywords*— Mass Irregularity, Response Spectrum analysis, Steel bracing system, X type bracing, V type bracing, Inverted V type bracing, Diagonal type bracing, Dynamic displacement.**

I. INTRODUCTION

India at present is fast developing country, which requires demands in increase of infrastructure facilities along with the growth of population. Due to increased population, the demand of land for housing is increasing day by day. To fulfil the need of the land for housing and other commercial offices, vertical development that is multistorey buildings are the only option. This type of development requires safety because these multistorey buildings are highly susceptible to additional lateral loads due to earthquake and wind. In broad, as the elevation of building increases, its reaction to lateral loads increases. Multistorey reinforced concrete buildings are vulnerable to excessive deformation, which necessitate the introduction of special measures to decrease this deformation.

The damage in a structure generally initiates at location of the structural weak planes present in the building systems. These weaknesses trigger further structural deterioration which leads to the structural collapse. A structure can be classified as vertically irregular if it contains irregular distribution of mass, strength and stiffness along the building height. As per IS 1893:2002, a storey in a building is said to contain mass irregularity if its mass exceeds 200% than that of the adjacent storey.

Steel braced frame is one of the lateral load opposing frameworks in multistorey structures. Steel bracing system enhances the resistance of the structure against horizontal forces by expanding its stiffness and stability. Bracings hold the structure stable by exchanging the horizontal loads, for example, quake or wind burdens down to the ground and oppose sidelong loads, in that way keep the influence of the structure. Steel bracing members in RC multistorey building is conservative, simple to set up, involve less space and give obliged quality and inflexibility. There are various types of bracing systems like X bracing, V bracing, inverted V bracing, K bracing, diagonal bracing and so on.

II. OBJECTIVE OF THIS PAPER

The objectives of this paper is to evaluate the response of various arrangements of lateral bracing system in mass irregular RC structure subjected to seismic load and to identify the suitable bracing system for resisting the seismic load efficiently.

III. DESCRIPTION OF BUILDING STRUCTURE

In this study, A G+9 storey reinforced concrete building of 4 bays in X direction and 3 bays in Y direction have been considered with mass irregularity at 3rd and 8th floor considered for investigating the effect of X type, V type, inverted V type and Diagonal type bracings and their arrangements in various positions in the building.

A) Following types of structural configuration is studied-

1. Reinforced concrete multi-storey building with X type, V type, inverted V type and Diagonal type bracing systems.

B) Other building details are given below: -

1) All RC Column sizes = 500mm x 500mm
2) All RC Beam sizes = 350mm x 450mm
3) Slab thickness = 200mm
4) Bracing details = ISHB 250
5) Grade of concrete = M-30
6) Grade of steel = Fe-500

IV. STRUCTURAL MODELLING AND ANALYSIS

A G+9 storey reinforced concrete building with X type, V type, Inverted V type and Diagonal type bracing provided on various positions in the building are analysed for earthquake loading. The method of seismic analysis used in this present study is Response Spectrum method which is a linear dynamic approach. earthquake loading is applied as per the recommendation of IS: 1893-2002. Building is assumed to be

located in seismic zone IV of India and rest on medium soil condition.

A) Following seismic parameters considered for the present study.

1) Zone factor for seismic zone IV = 0.24
2) Soil site factor for medium soil condition = 2
3) For important building Importance factor = 1
4) Response reduction factor = 5
5) Damping ratio = 0.05

B**)** The structures are demonstrated by utilizing computer programming **ETABS**.

1) The floor load is taken as 5 kN/m2
2) floor finishing load as 1 kN/m2.
3) Water proofing load as 2 kN/m2.
4) The live load is taken as 5 kN/m2.
5) Additional load taken for mass irregularity 10kN/m2

Note: - Load combinations are applied as per the recommendation of Indian standard codes.

A) Total 10 models are analysed in this study.
B) Two models of mass irregularity at 3rd and 8th floor without providing lateral steel bracing system.
C) Four models of mass irregularity at 3rd floor which include X, V, Inverted V, Diagonal bracing (In X and Y direction)
D) Four models of mass irregularity at 8th floor which include X, V, Inverted V, Diagonal bracing (In X and Y direction)

Figures given below shows the plan and various arrangements of X type, V type, Inverted V type and Diagonal type bracing in the building frame. In both X and Y direction.

Fig.1 Plan of Structure

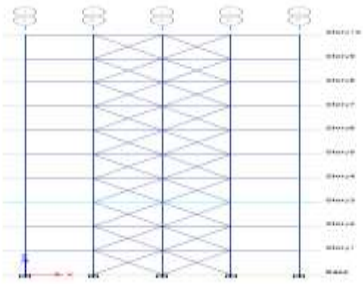


Fig.2 X Bracing System

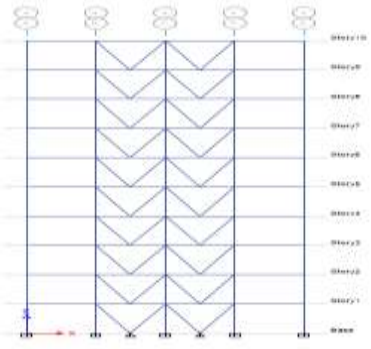


Fig.3 V Bracing System

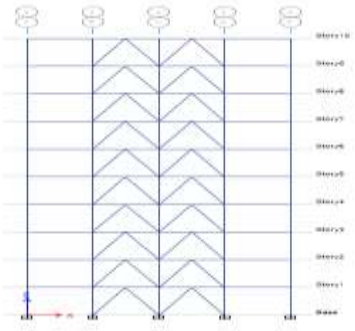


Fig.4 Inverted V Bracing system

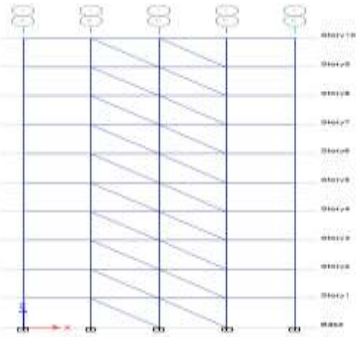


Fig.5 Diagonal Bracing System

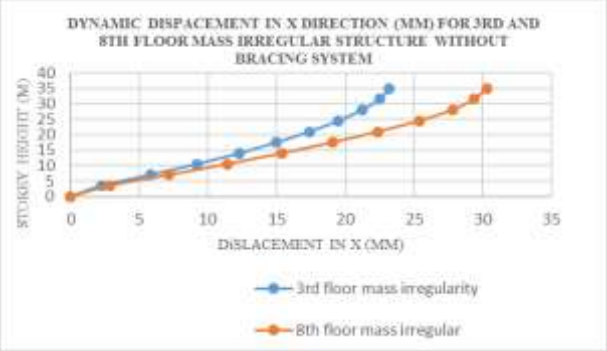
V. RESULTS

TABLE I

DYNAMIC DISPLACEMENT OF 3RD AND 8TH FLOOR MASS IRREGULAR STRUCTURES WITHOUT ARRANGEMENTS OF BRACING

Storey	Floor Ht.	Dynamic Displacement(mm) In X direction	
		Mass irregularity at	
		3rd Floor	8th Floor
Storey 10	35	23.2	30.3
Storey 9	31.5	22.5	29.4
Storey 8	28	21.2	27.8
Storey 7	24.5	19.5	25.4
Storey 6	21	17.4	22.4

Storey 5	17.5	15	19.1
Storey 4	14	12.3	15.4
Storey 3	10.5	9.2	11.4
Storey 2	7	5.8	7.2
Storey 1	3.5	2.3	2.9
Base	0	0	0

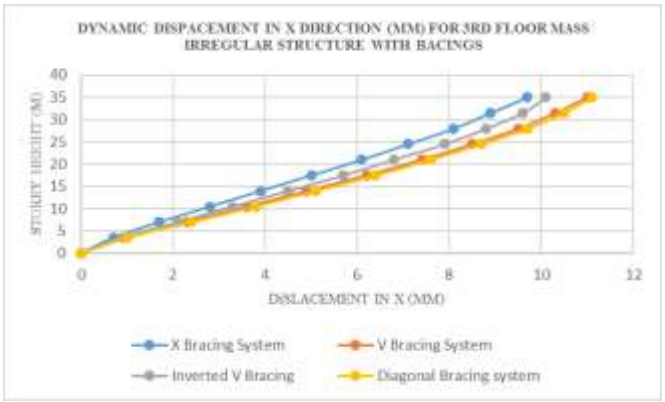


Graph 1. Comparison of Dynamic Displacement of 3rd and 8th floor mass irregular structure in X direction without Bracings

TABLE II

DYNAMIC DISPLACEMENT OF 3RD FLOOR MASS IRREGULAR STRUCTURE WITH VARIOUS ARRANGEMENTS OF BRACING SYSTEM

Storey	Floor Ht.	Dynamic Displacement (mm) in X-Direction			
		Bracing Systems			
		X	V	Inverted V	Diagonal
Storey 10	35	9.7	11	10.1	11.1
Storey 9	31.5	8.9	10.3	9.6	10.5
Storey 8	28	8.1	9.5	8.8	9.7
Storey 7	24.5	7.1	8.5	7.9	8.7
Storey 6	21	6.1	7.4	6.8	7.6
Storey 5	17.5	5	6.2	5.7	6.4
Storey 4	14	3.9	4.9	4.5	5.1
Storey 3	10.5	2.8	3.6	3.3	3.8
Storey 2	7	1.7	2.3	2.1	2.4
Storey 1	3.5	0.7	1	0.9	1
Base	0	0	0	0	0

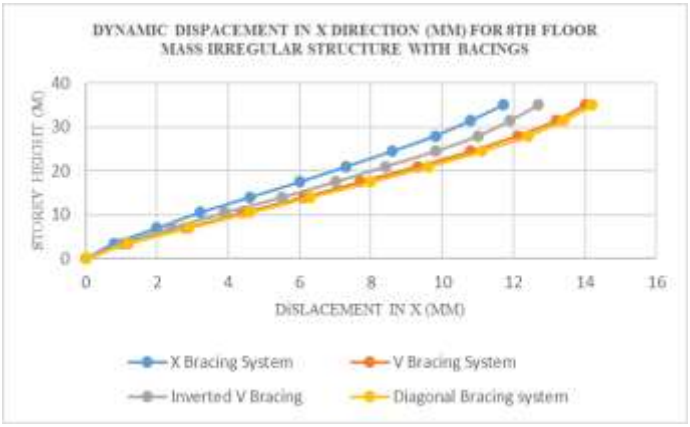


Graph 2. Comparison of Dynamic Displacement of 3rd floor mass irregular structure in X direction with Bracings

TABLE IIII

DYNAMIC DISPLACEMENT OF 8TH FLOOR MASS IRREGULAR STRUCTURE WITH VARIOUS ARRANGEMENTS OF BRACING SYSTEM

Storey	Floor Ht.	Dynamic Displacement (mm) in X-Direction			
		Bracing Systems			
		X	V	Inverted V	Diagonal
Storey 10	35	11.7	14	12.7	14.2
Storey 9	31.5	10.8	13.2	11.9	13.4
Storey 8	28	9.8	12.1	11	12.4
Storey 7	24.5	8.6	10.8	9.8	11.1
Storey 6	21	7.3	9.3	8.4	9.6
Storey 5	17.5	6	7.7	7	8
Storey 4	14	4.6	6.1	5.5	6.3
Storey 3	10.5	3.2	4.4	3.9	4.6
Storey 2	7	2	2.8	2.4	2.9
Storey 1	3.5	0.8	1.2	1	1.2
Base	0	0	0	0	0



Graph 3. Comparison of Dynamic Displacement of 8th floor mass irregular structure in X direction with Bracings

VI. DISCUSSION ON RESULTS

A) Table I and Graph 1 show the maximum lateral dynamic displacement for seismic load in X direction for mass irregularities at 3rd and 8th floor without bracing systems. The lateral displacements of the structure are compared.

1) The maximum lateral displacement at terrace level in X direction for mass irregularity at 3rd and 8th floor is 23.2 mm and 30.3 mm respectively.

B) Table II and Graph 2 show the maximum lateral dynamic displacement for seismic load in X direction for mass irregularities at 3rd floor for various types of bracing systems. The lateral displacements of the structure for various bracings system are compared.

1) The maximum lateral displacement at terrace level in X direction for mass irregularity at 3rd floor is 9.7mm, 11.00mm, 10.10mm and 11.10mm for X,

V, Inverted V and Diagonal type braced structural systems respectively.

C) Table III and Graph 3 show the maximum lateral dynamic displacement for seismic load in X direction for mass irregularities at 8th floor for various types of bracing systems. The lateral displacements of the structure for various bracings system are compared.

1) The maximum lateral displacement at terrace level in X direction for mass irregularity at 8th floor is 11.70mm, 14.00mm, 12.70mm and 14.20mm for X, V, Inverted V and Diagonal type braced structural systems respectively.

VII. CONCLUSION

- The concept of using steel bracing is one of the advantageous concepts, which can be used to strengthen or retrofit the existing structures.
- Steel bracings can be used as an alternative to the other strengthening or retrofitting techniques available as the total weight on the existing building will not change significantly.
- It is concluded that arrangements of bracing systems have considerable effect on seismic performance of the building. From all four arrangements of bracing system, X bracing system gives better performance.
- The lateral displacements of the building studied are reduced by the use of X type of bracing systems.
- Mass irregularity kept lower level as possible as to reduces significant lateral dynamic displacement.

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