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Study on Effective Steel Bracing System in Multi-Storied Structure

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Abstract:- The main purpose of all structural systems is to transfer all gravity loads and resist all lateral loads effectively. The use of steel bracing systems for strengthening seismically reinforced concrete (R.C.) frames is a good solution for improves earthquake resistance. Bracing system which forms an integral part of the frame and these structures has to be analyzed effective arrangement of bracing.

Here, we studied the seismic performance of reinforced concrete (RC) frame structure with different types of bracing at different position and without bracing system; various parameters and relativity are compared. A 7th story (G+6) structure is analyzed which located at seismic zone III, as per Indian Standard (IS) Code 1893: 2002 on STAAD-Pro software. The relative parameters observed, to compare the seismic performance of structure are axial force, displacement, story drift, and base shear.

Keywords:- *Axial Force, Base Shear, Lateral Displacement, STAAD PRO, Story Drift, etc*

I. INTRODUCTION

The main purpose of all structural systems is to transfer all gravity loads and resist all lateral loads effectively. Steel bracing system is mainly used to resist lateral load. Lateral loads are develops vibrations, high stresses, and forming sway movement and bracings system improves strength, stability and ductility in seismic design. It is necessary to design a structure to perform well under seismic performance under wind load and lateral load and also increases stiffness and strength.

Steel bracing system is economical and efficient method for strengthening of structures. This is always better option than reconstruction and replacement of structure. It's also good solution for economic considerations and immediate shelter problems of structure. Therefore retrofitting of structure is economical and faster process than demolition and reconstruction. Hence, retrofitting or strengthening of structures using bracing system is one of the most popular and effective method for mitigating seismic hazards especially in earthquake zone areas.

II. METHODS OF SEISMIC ANALYSIS

Earthquake causes vibration of the structure and forming inertia forces. Thus a structure must be able to safely transmit the horizontal and the vertical inertia forces. Hence, all ordinary structures are required earthquake-resistant design to pass safely adequate lateral load. Indian Standard (IS) Codes for Seismic design will guide an engineer to safely design the structure.

It was found that ordinary methods used for seismic analyses having limited areas of the application and cannot be used for all type of structures except detailed nonlinear time history analysis method.

Methods for seismic analyses are as follows.

1) Linear Static Analysis
2) Linear Dynamic Analysis
3) Nonlinear Static Analysis
4) Nonlinear Dynamic Analysis

III. OBJECTIVE OF THIS PAPER

The objective is to evaluate seismic performance of reinforced concrete (RC) frame structure with different types of bracing at different position and to identify the suitable bracing system.

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IV. MODELING AND ANALYSIS OF BUILDING

The RC structure is seven storied (G+6) building having floor plan with 4 openings having 4m distance along longitudinal direction and 3 openings having 4m distance along transverse direction as shown in figure. 2.

- The height of the each floor is 3 M. while thickness of slab is 0.125 M and brick wall is 0.230 M.
- The live load is 3 KN/m^2 and Floor finish load is 1 KN/m^2 for all floors.
- Structure is located in seismic region III.
- For Seismic analysis Staad-pro V8i software is used.
- Seismic performance are considered as per IS 1893 – 2002 and IS 456-2000.

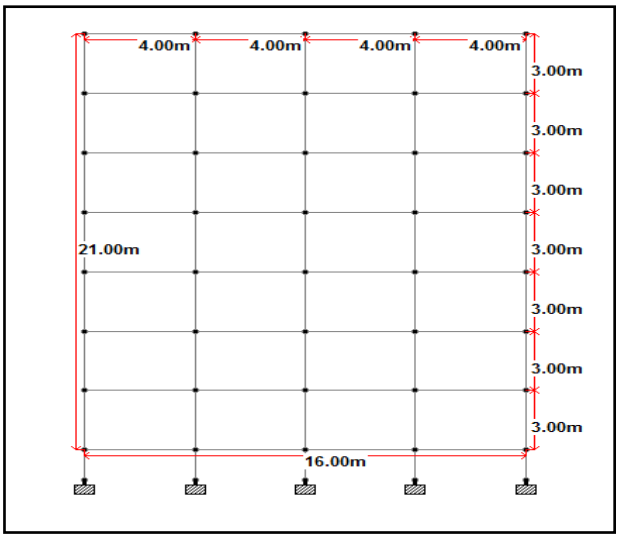

Fig 1:- Elevation of Building.

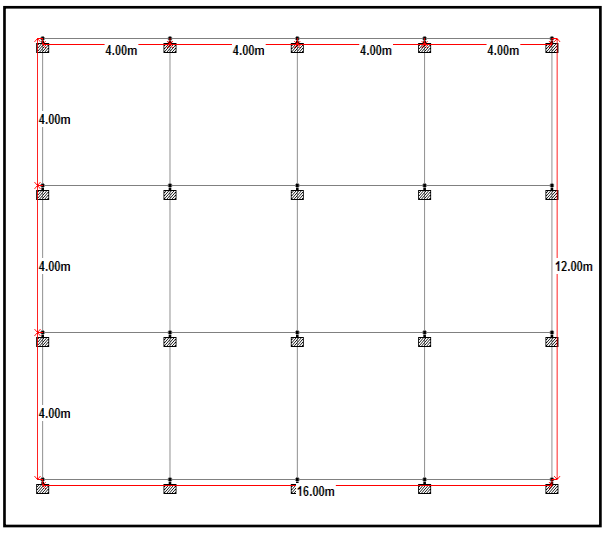

Fig 2:- Plan of building

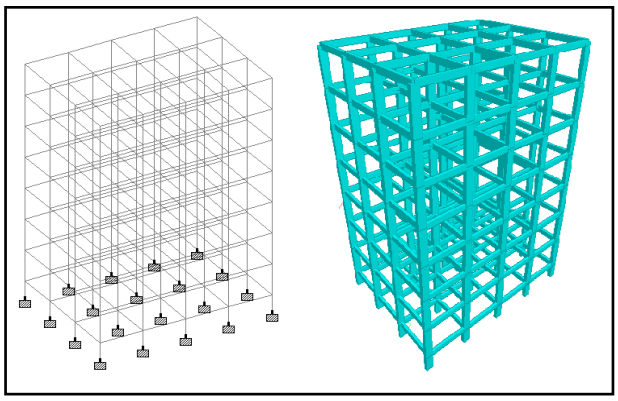
Fig 3:- Building Without Bracing

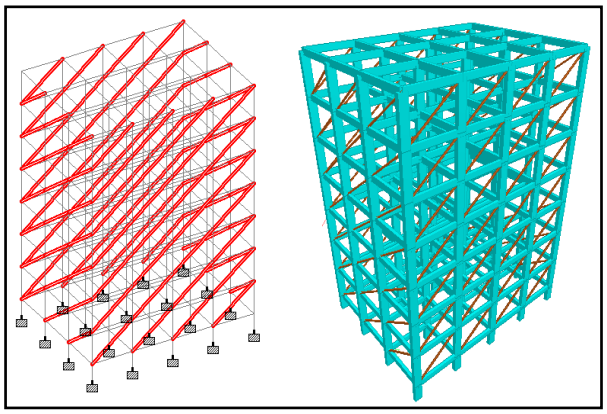
Fig 4:- Diagonal Bracing

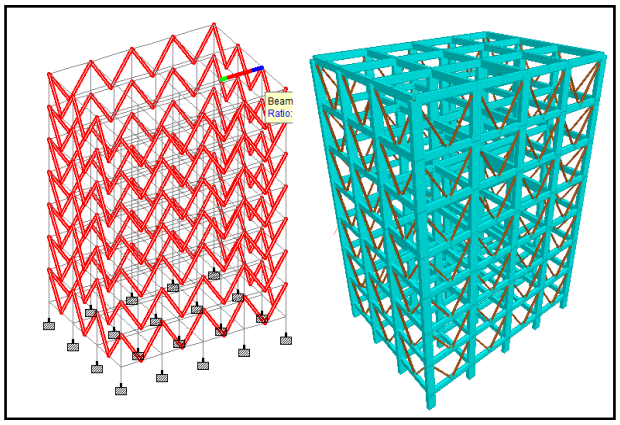
Fig 5:- V Type Bracing

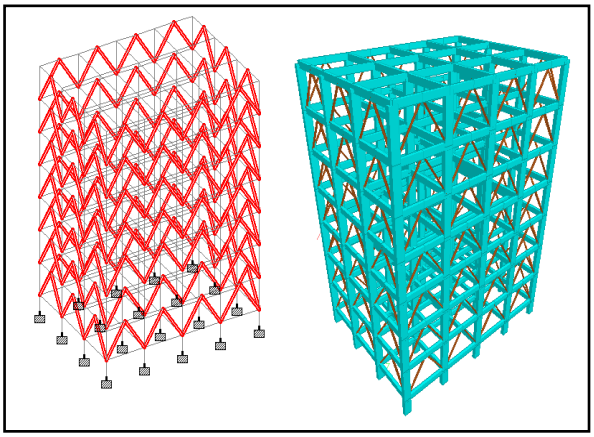
Fig 6:- Inverted V Type Bracing

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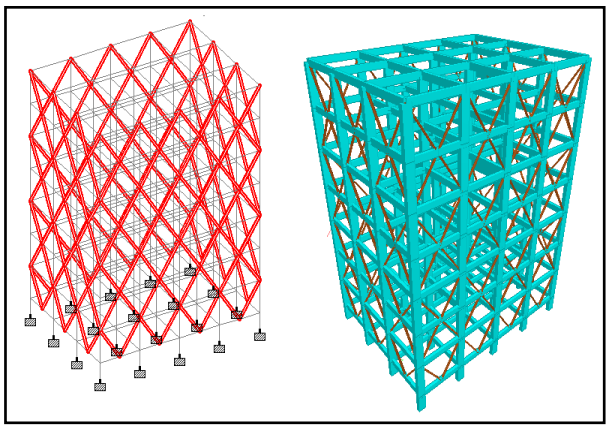

Fig 7:- Combine V Type Bracing

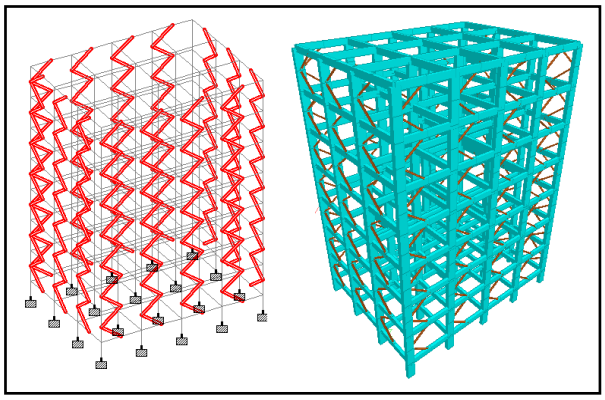

Fig 8:- K Type Bracing

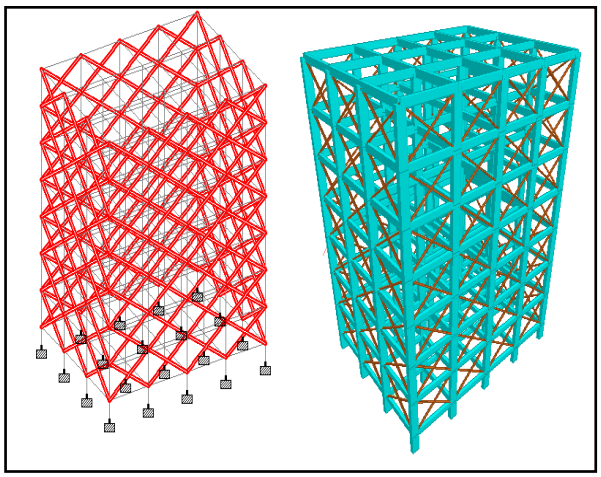

Fig 9:- X Type Bracing

V. ANALYSIS AND RESULTS

Here different type of bracing system is provided all peripheral sides of the structural model. Analysis is done and after that we compare the result.

A. LATERAL DISPLACEMENT FOR G+6 BUILDING

Here we observed that lateral displacement is minimizes when bracings are provided, while the displacement is high for without bracing.

Floor Level	With-out Bracⁿ.	Diagonal Bracⁿ	V Bracⁿ	In. V Bracⁿ	Com. V Bracⁿ	K Bracⁿ	X Bracⁿ
7th	23.57	12.63	11.68	12.27	11.43	15.17	10.37
6th	22.37	12.06	11.12	11.92	10.93	14.47	9.93
5th	20.09	10.84	9.98	10.99	9.82	13.01	8.90
4th	16.80	9.017	8.30	9.04	8.16	10.85	7.37
3rd	12.81	6.828	6.28	6.75	6.16	8.24	5.55
2nd	8.43	4.477	4.11	4.38	4.04	5.41	3.62
1st	4.08	2.167	1.99	2.11	1.95	2.62	1.75

Table 1:- Lateral Displacement (mm)

B. INTER STOREY DRIFTS FOR *G+6* BUIDINGS

As per the lateral displacement story drift also minimizes when bracing system is provided, while the story drift is maximum for the structure without bracing.

Floor Level	With-out Bracⁿ	Diagonal Bracⁿ	V Bracⁿ	In. V Bracⁿ	Com. V Bracⁿ	K Bracⁿ	X Bracⁿ
7th	1.20	0.56	0.56	0.34	0.49	0.70	0.44
6th	2.27	1.22	1.13	0.93	1.1	1.46	1.02
5th	3.28	1.82	1.67	1.94	1.66	2.16	1.53
4th	3.99	2.18	2.02	2.29	1.99	2.60	1.82
3rd	4.37	2.35	2.16	2.36	2.12	2.82	1.93
2nd	4.35	2.3	2.12	2.27	2.08	2.79	1.87
1st	4.08	2.16	1.74	1.85	1.71	2.62	1.75

Table 2:- Story Drift (mm)

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C. AXIAL FORCE IN COLUMN FOR G+6 BUILDINGS

It can be observed from the table that the axial forces are maximum for X type of bacing systems, while these are minimum for the system without bracing.

Floor Level	With-out Bracⁿ	Dia. Bracⁿ	V Bracⁿ	In. V Bracⁿ	Com. V Bracⁿ	K Bracⁿ	X Bracⁿ
7th	31	26	77	16	60	15	38
6th	142	155	205	125	127	135	171
5th	252	287	333	256	304	262	306
4th	362	418	459	386	371	389	438
3rd	470	547	582	512	536	516	567
2nd	577	671	699	631	602	640	689
1st	681	790	811	748	816	762	806
G	790	916	925	928	931	916	958

Table 3:- Axial Force (kN)

D. ANALYSIS RESULTS OF BASE SHEAR

Base shear increases when bracing are provided as compared to without bracing system which indicates that stiffness of structure has increases.

Bracing System	**Base Shear (kN)**
Without bracing	849.96
DIAGONAL bracing	852.82
V Bracing	854.08
INVERTED V bracing	853.68
COMBINE V bracing	854.08
K bracing	852.54
X bracing	855.67

Table 4:- Base shear (kN)

VI. CONCLUSIONS

The use of steel braced RC frames as the main lateral load resistance system for RC structures is a promising technique. Bracing system increases not only the lateral stiffness but strength capacity also. Steel bracings used as an alternative method to improve retrofitting techniques and strengthening.

1. The percentage reduction of lateral displacements for structure with X bracing to the without bracing is shown in the table below.

Lateral Displacement	Without Bracing in mm	X Bracing in mm	Reduction in Percentage
7th story (All side)	38.68	19.02	50.81

Table 4

2. Therfore X type of bracing is found more effective for lateral displacement but other types of bracing can also be used as per the site requirement and exterior design and aesthetic conditions.
3. The story drift also minimizing when bracings are provided, thus the overall response of the building decreases.
4. Axial force increases at the ground level for X bracing system as compared to other bracing system.
5. Base shear increases when bracing are provided