ANALYSIS OF RC BUILDING EQUIPPED WITH VIBRATION CONTROL DEVICES AS METALLIC FUSES

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***Abstract*—** Research and development of vibration control devices for structural applications have roughly a 25-years history. The basic function of vibration control devices when implemented into the structure of a building is to absorb or consume a portion of the input energy. The vibration control devices that are chosen for investigation include metallic bracings and metallic x-plate damper, which are used as metallic fuses. Metallic fuses are supplemental energy dissipating devices that are fabricated into the structure to ensure safety of primary structural members. They are installed in the second and third bay of building. Different configuration of bracing and X-plate metallic damper are used. The earthquake analysis is carrying out for 8storey building by ETAB-2016 software and designed according to IS 1893:2016 code specification. The static pushover and dynamic time history analysis are carried out. Inter-storey drift, storey displacement, shear force and moment proved to be the key constraints in accessing the performance of the building structure.

***Keywords*—** **X-Bracing, V-Bracing, Inverted V-Bracing, X-Plate Metallic Damper, pushover Analysis, Time history Analysis.**

I. INTRODUCTION

This paper presents briefly concept on current practice and development under the application of metallic fuses for safety of the structure. A seismic design is based upon combination of strength and ductility. For small, frequent seismic disturbances, the structure is expected to remain in the elastic range. This philosophy has led to the development of a seismic design codes featuring lateral force methods and more recently, inelastic methods. Ultimately, with these approaches, the structure is designed to resist an equivalent static load and results have been reasonably successful. As a result, from the statically point of view, new and innovative concepts of structural protection system advanced and are at various stages of development. For application of metallic fuses bracings & metallic damper taken as metallic fuses.

Bracing systems can be constructed in many different configurations, often established by specific clearance constraints or to behave in predetermined fashion. These systems may be designed and detailed as concentrically or eccentrically braced frames. A metallic damper or a metallic fuse is capable of sustaining many cycles of stable yielding deformation resulting in high level of energy dissipation. The metallic damper also called Structural fuse. The concept behind this device comes from the fuse of an electric circuit.

II. METHODOLOGY

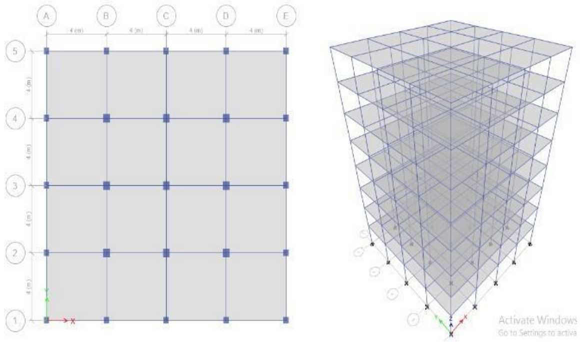
In order to investigate seismic performance of RCC frame buildings with and without bracings and damper a 8 storey symmetrical reinforced concrete moment-resisting frame building is considered. The considered symmetrical building has of 16m in length and

Divided into 4 bays as shown in fig.1. In modeling of soft storey building frame other relevant data is given as below,

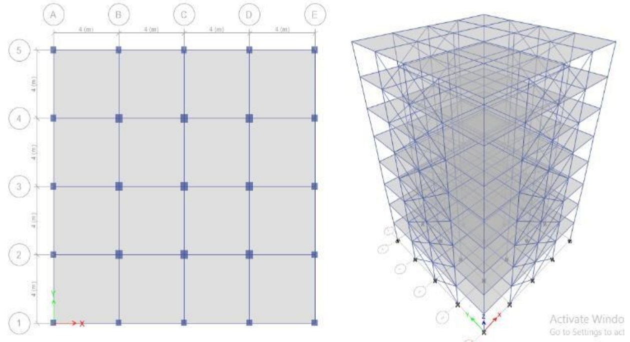
Table 1: Building Specifications

Size of building	16 m X 16 m
Grade of Concrete	M20
Grade of Steel	Fe415
Slab thickness	150mm
Size of beam	300 mm x 350 mm
Size of columns	350mm x 400 mm
Live load on floor	3kN/m^2
Floor Finish	1kN/m^2

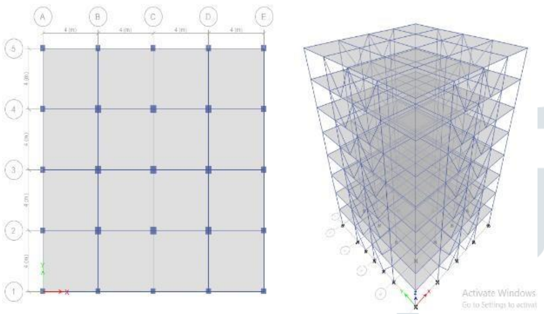
Seismic zone	IV



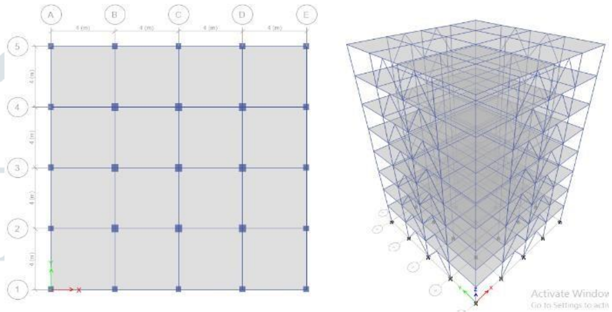
Plan and 3D view of 8SBF



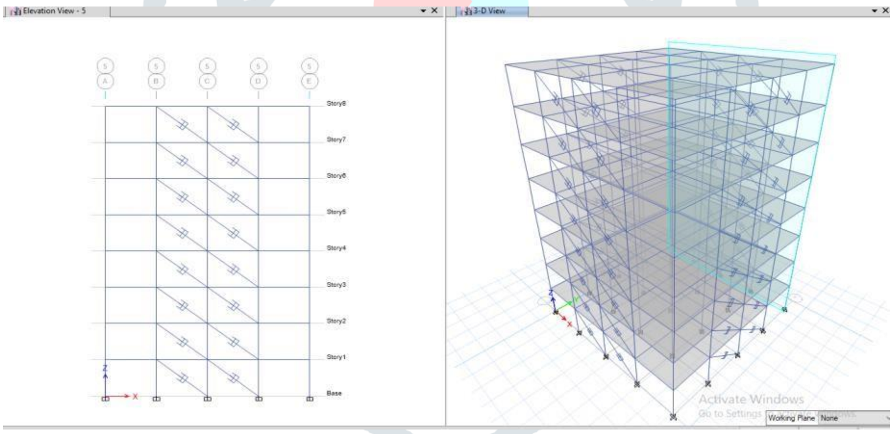
Plan and 3D view of 8SXBS



Plan and 3D view of 8SVBS



Plan and 3D view of 8SIVBS



3D and Elevation view of modelling of X plate damper

A. Time History Analysis

Time history analysis also known as nonlinear dynamic analysis, time history uses seismic data when structural behaviour is nonlinear in nature. To perform non-linear analysis, a representative earthquake time history is required for a structure being evaluated. Time history analysis is a systematic analysis of the dynamic response of a structure to a specified loading that may vary with time. Seismic response of a structure under dynamic loading of representative earthquake is determined by using time history analysis. For analysis purpose Imperial Valley (6.95), North Ridge (7.36), Loma Prieta (6.6) time histories with their Richter magnitude are selected.

B. Pushover Analysis

Amongst the natural hazards, earthquakes have the potential for causing the greatest damages. Since earthquake forces are random in nature and unpredictable, the engineering tools need to be sharpened for analyzing structures under the action of these forces. Earthquake loads are to be carefully modeled to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated. In this context pushover, analysis, which is an iterative procedure, is looked upon as an alternative for the conventional analysis procedures.

III.RESULTS AND DISCUSSION

A comparative study is presented between the performances of different bracings and metallic damper for the application of nonlinear static analysis. Seven-type model were modelled 1.bare frame, 2.with X-brace and 3rd -4th with V &IV. Similarly, 5th 6th & 7th with 10 x-plate damper, 15xpd, 20xpd resp.

8SBF- 8 Storey Bare frame, 8SXBS – 8 Storey With X brace, 8SVBS – 8 Storey With V brace, 8SIVBS – 8 Storey With IV brace

8S10XPD- 8 Storey with 10 X plate damper, 8S15XPD - 8 Storey with 15 X plate damper, 8S20XPD- 8 Storey with 20 X plate damper.

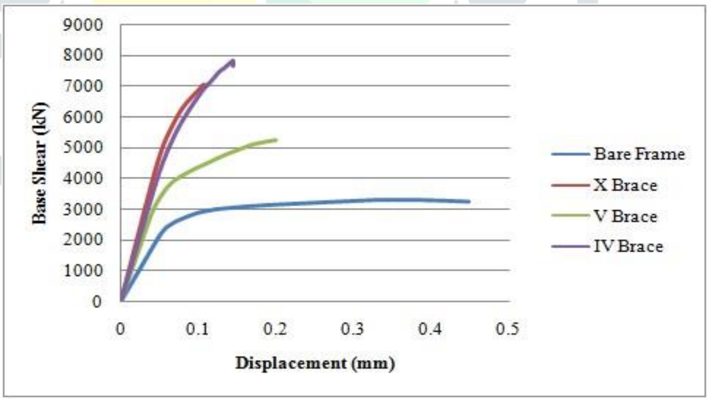
PUSHEOVER ANALYSIS

Table.1 shows various properties of structure that are affected due to the installation of various configuration of bracing in the bare frame structure. The properties of interest are yield shear, yield displacement, target displacement, target shear and ductility ratio.

1. Effect of Bracing on Various Properties of Structure

Sr. No.	Properties	8SBF	8SXBS	8SXVBS	8SIVBS
1	Yield Shear (kN)	3102.38	5635.48	3923.92	5430.67
2	Yield Displacement (mm)	70.1	57.7	53.9	63
3	Target Shear (kN)	3262.31	7030.323	5236.734	7676.1
4	Target Displacement (mm)	422	110	192	137
5	Ductility Ratio	6.877	1.858	3.865	2.237

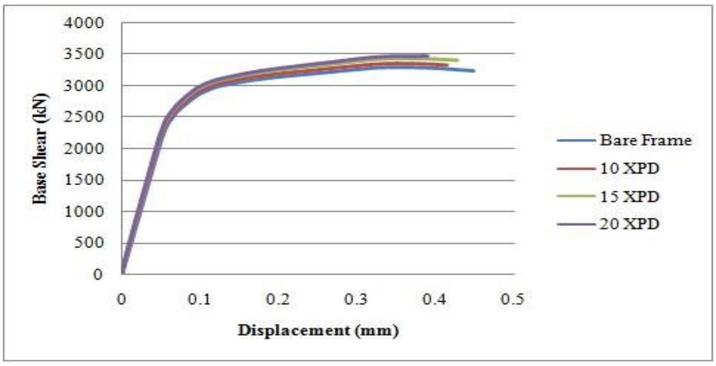
From table we observed results that base shear is increased by some percentage by using different configuration of bracing as compare to bare frame as shown in fig.



Pushover Curve for Model 8SBF, 8SXBS, 8SVBS, 8SIVBS

2. Effect of X Plate Damper on Various Properties of Structure

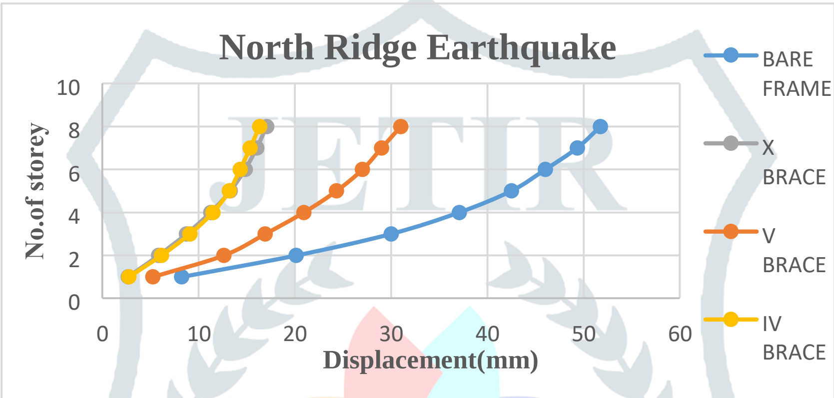
From the figure, it is observed that all plate of X plate damper are increases base shear. Same work is done for damper as above



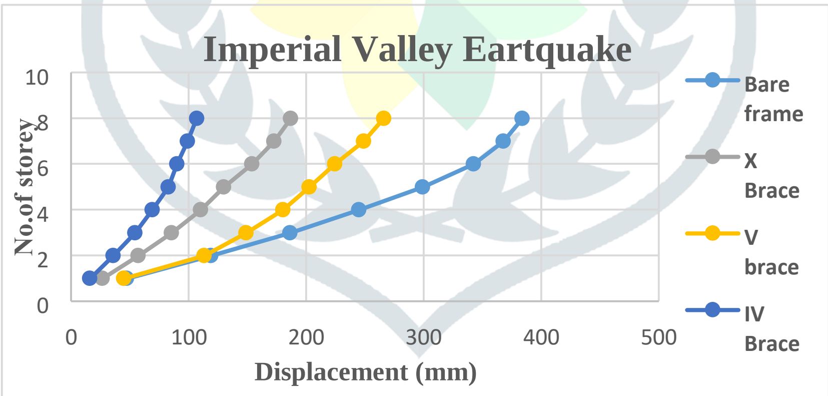
Pushover Curve for Model 8SBF, 8S10XPD, 8S15XPD, 8S20XPD

TIME-HISTORY ANLYSIS

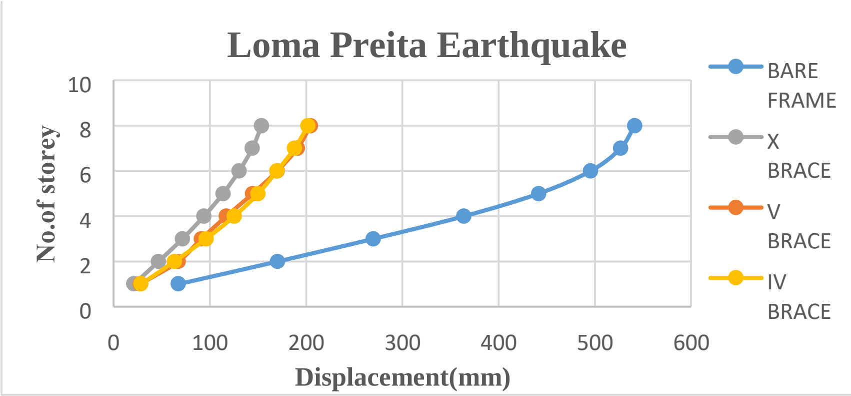
3 different time histories ground motion are taken for analyzing structure with and without bracings and metallic damper.



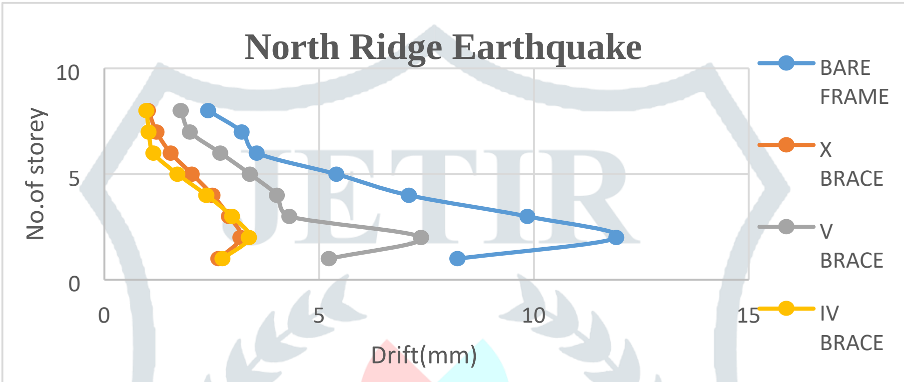
A. Displacement for North Ridge earthquake



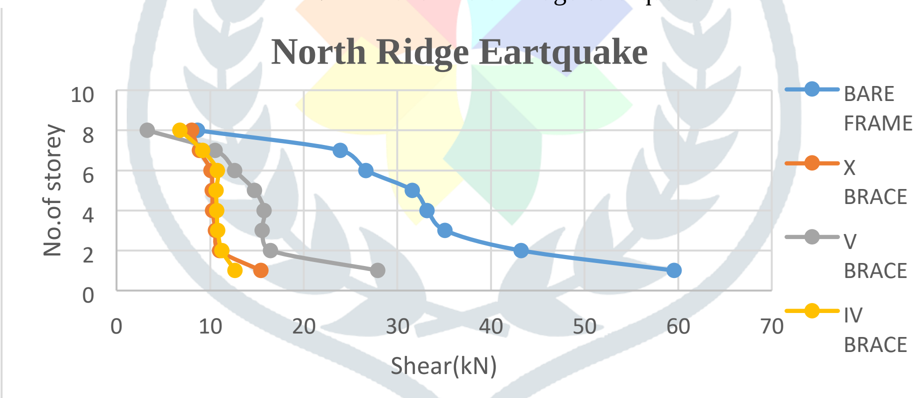
B. Displacement for Imperial Valley earthquake



C. Displacement for Loma Preita earthquake

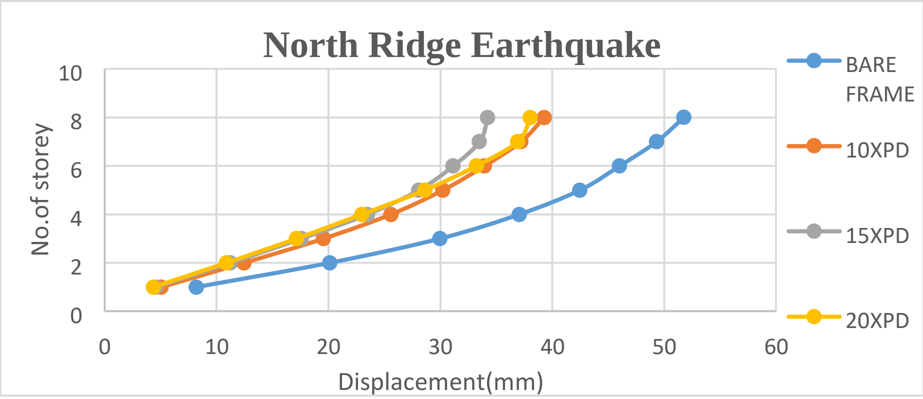


A. Drift for North Ridge earthquake

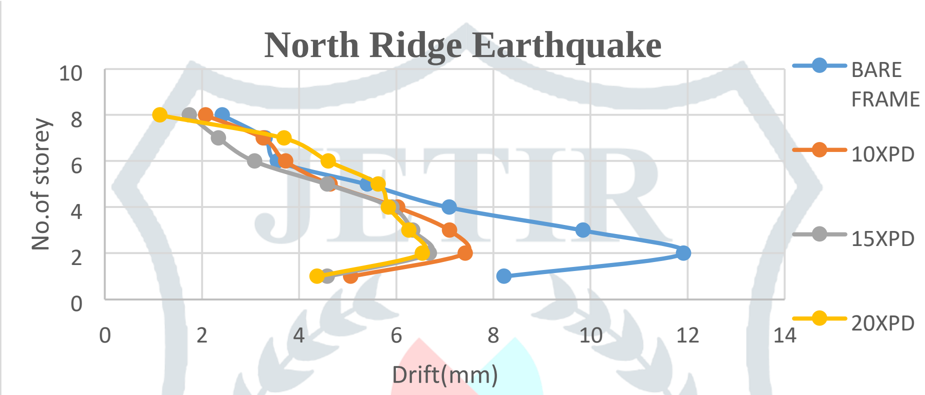


B. Shear for North Ridge earthquake

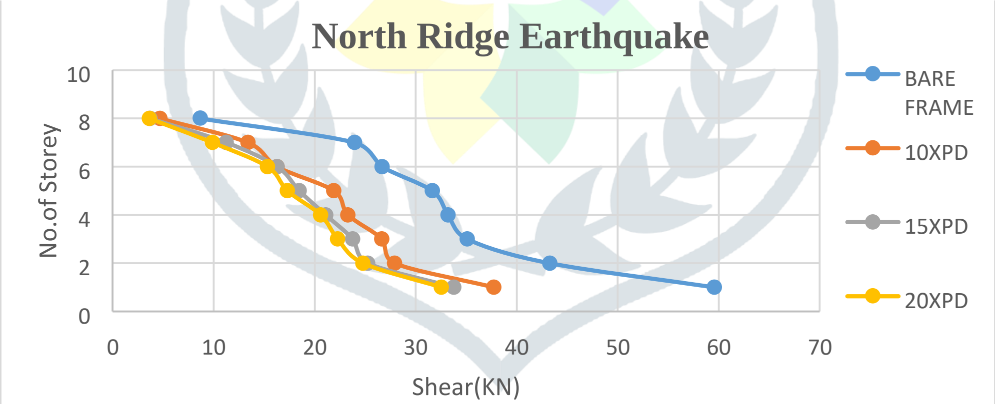
For X plate damper



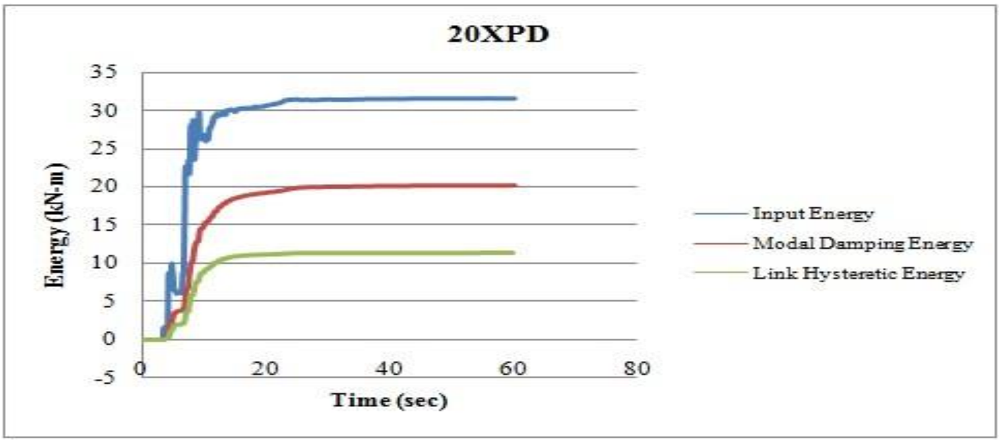
A. Displacement for North Ridge earthquake



B. Drift for North Ridge earthquake



C. Shear for North Ridge earthquake



Input and Energy dissipation curves for 8S20XPD

CONCLUSIONS

As compare with bare frame some results of bracings and X plate damper are as follows

- Top storey displacement reduced by 63.35%, 44.25% and 67.85% for X, V and Inverted V bracing system respectively.
- X brace, V brace and inverted V brace curtailed the maximum storey drift by 68.48%, 34.26% and 70.21% respectively.
- 10XPD decreased top storey displacement by 11.88%, 15XPD by 17.09% and 20XPD by 24.99%.
- X brace, V brace and inverted V brace increased the yield shear capacity of building by 44.95%, 14.56% and 41.31% respectively.
- 10XPD, 15XPD and 20XPD curtailed the target displacement by 4.97%, 10.42% and 23.22% respectively.
- 10XPD dissipated 22.87% input energy through hysteretic behavior where as 15XPD and 20XPD dissipated 29.69% and 35.4% input energy.
- All the plates in X-Plate Damper have yielded well and dissipated considerable amount of energy.
- Bracing and X plate damper curtailing response is most effective than no energy dissipation device.
- Comparison of X brace system and X Plate damper, X brace system is more effective in reduction of response such as Displacement, drift, shear and moment of building.

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