FEA OF SEISMIC RESISTANT STRONG BACK SPINE SYSTEM COUPLED WITH STEEL STRUCTURAL FRAMES

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Abstract – *In case of steel structure to resist the lateral force and increase the stiffness of steel frame, bracings play very vital role. Bracing will make structure indeterminate. But it stiffens the structure and also helps to resist the sway of the structure. Bracings are straight member and carry only axial forces. Buildings are subjected to loads like earthquake, wind, etc. so it is necessary to provide additional load resisting system in order to ensure safety. We are using bracings to improve the performance of steel structure. But if we are using bracings only, then buckling takes place and even collapse occurs. So, in order to improve the performance, it is necessary to study the effect of different conventional bracing system and comparing the conventional bracing system with zipper frames. This study will give an idea about the behavior of different conventional and innovative bracing systems and thus the most efficient system can be found out.*

Key Words: **steel frame, bracing, buckling, zipper frame, collapse.**

1.INTRODUCTION

It is desirable to enhance the ability of concentric braced frames to avoid concentration of deformations and damage in a few stories. The primary function of bracing is to provide stability and resist lateral loads, either from diagonal steel members or from a concrete 'core'. For bracing frames, beams and columns are designed only to support vertical load, since the bracing system should carry all lateral loads.

Here, we are introducing strong back spine system coupled with steel structural frames. And it can be used in steel, composite and precast members. We are providing different types of conventional bracings and zipper braced frame. We study the performance of structure by providing different bracings in a normal structure and also a seismic structure. And here we are performing pushover analysis, seismic analysis which includes modal analysis and time history analysis.

2. FINITE ELEMENT MODELLING

2.1 General

To investigate the structural behavior of frames, finite element models were developed using Ansys 19. BEAM188 Homogenous Structural Solid is well suited to modelling irregular meshes. The element can be used for slender or stout beams.

2.2 Scope

The work is limited to modelling and analysis of steel structural frames. Buildings are often subjected to lateral loads like earthquake, wind etc. so it is necessary to provide additional lateral load resisting systems to them in order to ensure safety. Many of the lateral load resisting systems used nowadays are prone to cause damage concentrations in single story resulting in ultimate collapse by soft story mechanism. So, it is very necessary to study the effect of different lateral load resisting bracing systems to distribute the inter story drift more evenly and thereby mitigating the damage concentrations in a particular story. The study includes the behavior of five models in which no bracing provided, an x brace provided, a v- type brace, and v+ v inverted brace, and a zipper brace provided.

2.3 Geometry

A six- story model building was used to examine the behavior of SBS and other concentric braced frames. Floor beams are assumed to have typical pin connections to the columns. Each direction has five beam spans and the widths are equal to 9.14m. each story id 3.96m tall, except the ground story, which is 5.49m high. The occupancy of the building is assumed to be that of a typical office building.

Table -1: Material Properties of Steel

Material Properties	Structural steel

Young's Modulus (MPa)	2.06e+05
Poisson's ratio	0.3
Yield Strength (MPa)	367

2.4Meshing

Meshing divides the whole component into a finite number of small elements as per requirement. Size of the element must be as small as possible to achieve accuracy. In this analysis, fine mesh was adopted to achieve maximum accuracy in results. Solid models are converted into a finite element model after meshing.

2.5Loading and Boundary Conditions

To simulate the real condition, boundary conditions of specimens were set to be same as in the test. Here we are performing pushover analysis. Braces are fixed and we are applying a lateral force. The columns are fixed at bottom. That is, frame was analyzed with fixed support at bottom to restrain axial deformation.

2.6 Analytical Results and Discussions

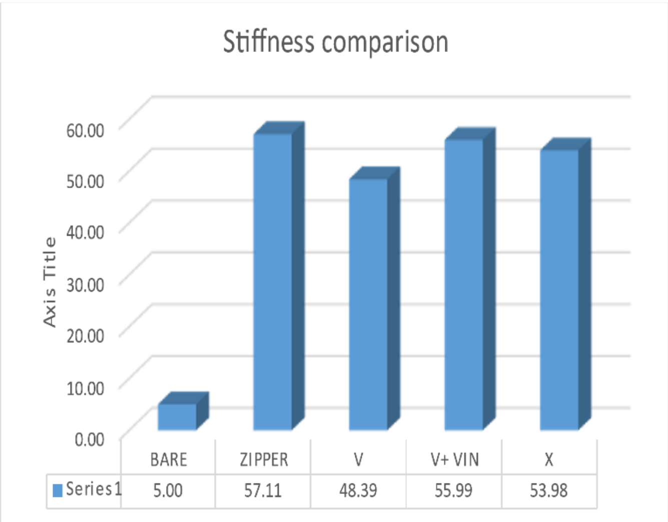

Chart -1: Comparison of stiffness

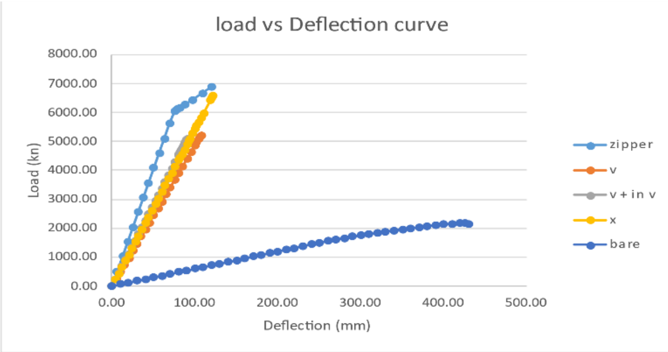

Chart -2: Load vs Deflection Curve

Table -2: Comparison of Bracings

Comparison			
	Deflection (mm)	Load (KN)	Stiffness (KN/mm)
Bare	430.32	2153.40	5.00
Zipper	120.67	6891.50	57.11
V type	107.33	5194.00	48.39
V+V inverted type	90.92	5090.40	55.99
X type	122.23	6598.50	53.98

3.SEISMIC ANALYSIS

To determine seismic responses, seismic analysis of framed structure was carried out. To analyze the seismic performance of frame, two analysis were conducted here. A) Modal Analysis B) Time history Analysis.

3.1 Modal Analysis

Modal analysis is the study of the dynamic properties of structures under vibrational excitation. When a structure undergoes an external excitation, its dynamic responses are measured and analysed. This field of measuring and analysing is called modal analysis. In structural engineering, modal analysis is applied to find various periods that the structure will naturally resonate at, by using structure's overall mass and stiffness. Frequency and mode shape of a model is determined by modal analysis. When the models are subjected to cyclic or vibration loads, dynamic response of structures due to these external loads acting, which include resonance frequencies (natural frequencies), mode shape and damping, are estimated.

3.2 Time History Analysis

One of the important analysis for investigating seismic behavior of a structure is time history analysis. It is also known as Non-linear Dynamic analysis (NDA). It is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear. To perform such an analysis, a representative earthquake time history is required for a structure being evaluated. Time history analysis using earthquake accelerograms is one of the suggested methods by most regulations to investigate seismic behavior of structures. This study used accelerograms of Elcentro Earthquake. Scaled records of Peak Ground Acceleration (PGA) were considered for dynamic time history analysis.

3.3 Analysis and Results

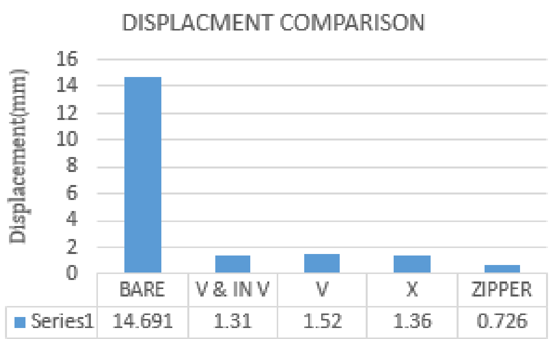

Chart -3: Comparison of Displacement

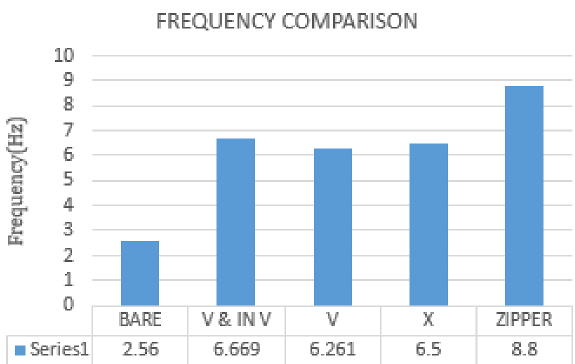

Chart -4: Comparison of Frequency

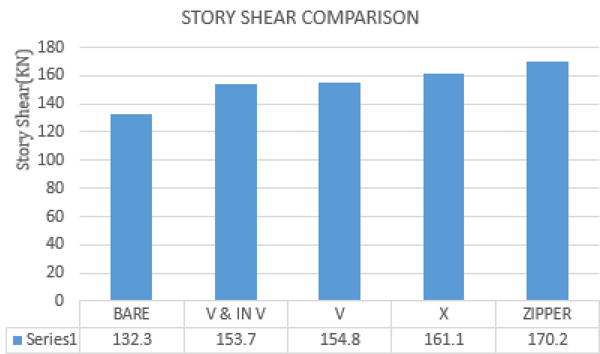

Chart -5: Comparison of Story Shear

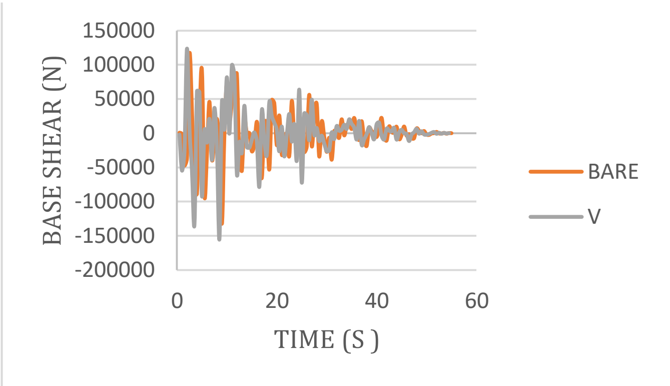

Chart -6: Base Shear Comparison (Bare vs V-type)

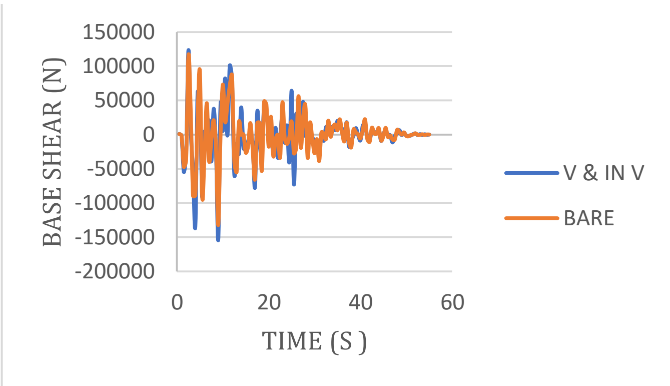

Chart -7: Base Shear Comparison (Bare vs V + V inverted-type)

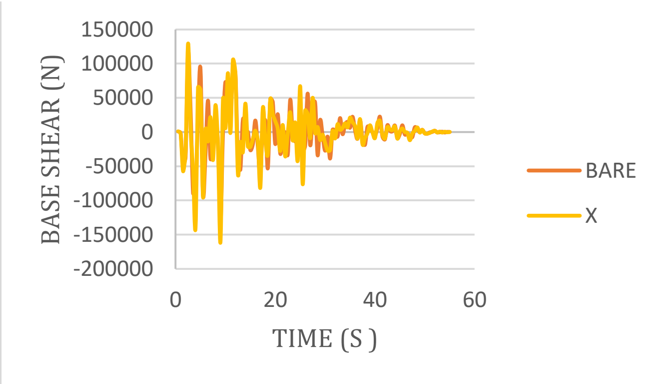

Chart -8: Base Shear Comparison (Bare vs X-type)

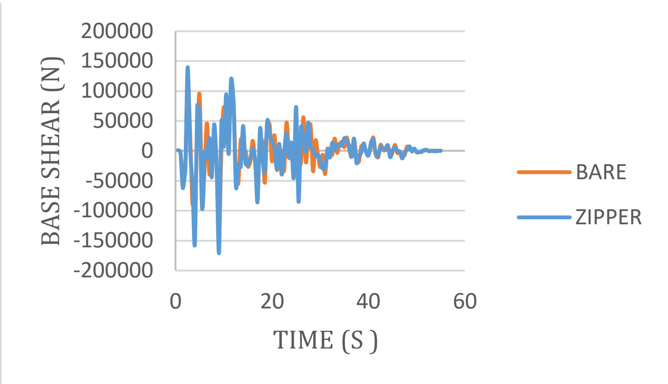

Chart -9: Base Shear Comparison (Bare vs Zipper)

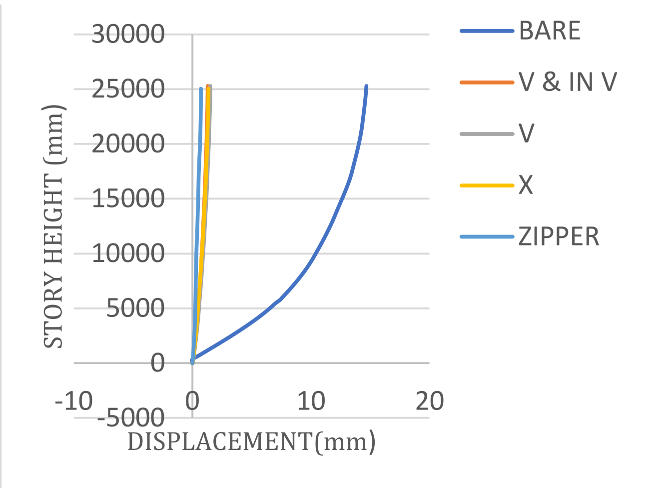

Chart -10: Story- Displacement Graph

4. CONCLUSIONS

In this study, a comparison of different types of conventional and innovative bracings were done and following conclusions were arrived at:

- In non-linear pushover analysis, Zipper frames are better than other conventional bracing system.
- From the analysis, it is clear that zipper frames have more capacity to carry load than other bracing system.
- Zipper frames have more stiffness as compared to other bracing systems.
- In seismic analysis, we are performing two types of analysis: 1) modal analysis 2) time history analysis.
- In modal analysis, for zipper frames decreasing in the time period indicates the vibration characteristics is very much reduced and stiffness is getting increased.
- In Time history analysis, for zipper frames displacement is around 50% lesser than that of other type of bracings. And the base shear is maximum for zipper and it can resist more earthquake force than other conventional bracing.

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