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DESIGN AND ANALYSIS OF GABLE FRAME BY USING DAMPERS AND BRACINGS

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Abstract- *Single storeyed gable frame have been popular among the architects and engineers to support sloping roofs, for industries and also other column free areas. Though definite methods of analysis of these frame are know, they often turn to be tedious and time consuming because of built in indeterminancy. In the work presented an attempt has been made to represent forces and moments, at a salient points on gable frame with fixed supports for selected loading conditions. These graph may be used for design of gable frame made of steel, concrete or open web sections.*
The current study focused on the seismic response of high rise gable frame structures along with structural systems bordering on bracings and fluid viscous dampers at various location. The structure is analyzed, accordance with Indian standard code IS 1983(Part1) 2002, seismic zone V and medium soil. Equivalent static method and Response Spectrum has been employed for each model, ETABS software is used to examine the effect of structural systems on seismic parameters. From the results it's concluded that structure with bracings and dampers have time period of 74%. Lateral displacement of 34% in x direction and 89% in y direction story drift of 30% in x direction and 88% in y directions .Hence bracings and dampers located at rigid gable frame structure to reduce the response effectively

Key Words: **ETABS, Lateral Load, Dissipate Energy, Structural Systems, Response Spectrum, Story Drift, Story Displacement, Dampers, Fluid Viscous Damper Etc.**

1. INTRODUCTION

Rigid design of metal frame systems is well suited for manufacturing facilities, field houses, storage facilities, stadiums, indoor sports courts. The rigid system of framing is economical, and has strong versatility. Clean architectural appearance to the rigid frame of single span steel is very common. This type of rigid structural feature in single span steel is in fact modern construction. Rigid introduction of frames as a new trend of structural engineering brought. By wasting a significant portion of the building's interior, the single-story rigid frame style of buildings can accomplish any proposition. And it is well suited to factory, manufacturing buildings.

1.1 GABLE FRAMES:

Because of its low price / kilogram and meter / tonnage, because of it is a simple structure, the gable frame is very suitable for industrial, storage and complexes. It is a most robust metal structure and at the same time it is good flexible as well as being ideal for use in terms of height, width and weight. The structure can accommodate cranes or other machinery freely. Single span gable analysis by moment distribution. The frame has two degrees of freedom for joint translation, requiring two imaginary braces to keep the joints from moving. The tree moment distribution analyzes provided in the resolution are for the frame without joint displacement.

1.2 ADVANTAGES:

1. Gable frame offers sloping roof and potential quick drainage.
2. Gable frame has more headroom for the interior that needed vechicle or machine movement.
3. Gable frame offers strong natural lighting
4. Gable frame has improved ventilation with motor roofing etc..,
5. The Inclined rafter member undergoes less flexural stress compared to the flat beam member, the member segment is more exploited as the member is subject to axial forces.

3. OBJECTIVES OF THE STUDY:

1. Analysis of Gable Frame by using software using ETABS.
2. The Gable Frame analyzed for a symmetric load and symmetric geometry only.
3. Uniformly distributed load has been taken for gable frames.

4. To study the variations in time period for different structures with combination of Gable Frames
5. Analysis for maximum shear force and bending moment is done with Respect dampers and bracings for gable frame.
6. Analysis for maximum story displacement is done with respect to dampers and bracings for gable frame.
7. Analysis for maximum story drifts is done with respect to dampers and bracings for gable frame.

4. METHODOLOGY

4.1DAMPERS:

Seismic dampers allow the structure stand extreme input energy and to minimize dangerous deflections, forces and accelerations to the structures and occupants. Several types of seismic dampers are available including viscous damper, friction damper, damper making, magnetic damper tuning, and mass damper tuning.

Damper Levels;

1. Viscous Dampers.
2. Viscoelastic Dampers.
3. Friction Damper.
4. Tuned Mass Damper (TMD).
5. Yielding Dampers.

Friction dampers are built to have movable parts which may slip overly each other during seriously earthquake. When the pieces fall over each other they create friction that uses some of the energy from the earthquake that goes into the building as shown below figure.

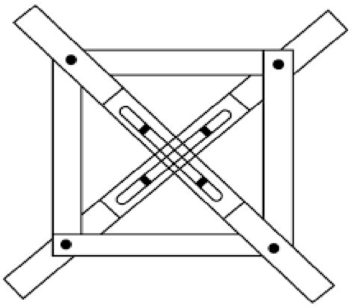

Fig4.1(a) Friction Damper

4.2TRUSS:

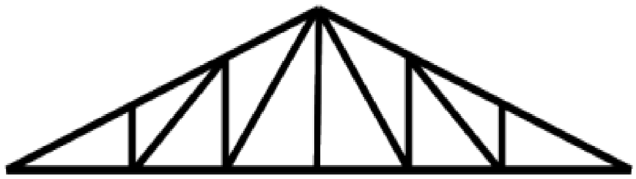

Fig4.2(a)truss

A truss is a structure made up of members organized into connected triangles such that the entire assembly acts as one entity. Bridges, walls, and towers are most commonly found in trees

Trusses are typically made up of three basic elements:

- Usually a top chord in compression.
- A low chord that is normally in tension.
- Brace between the chords top and bottom.

4.3ETABS SOFTWARE:

Software technology has allowed many civil engineering problems to be accurately resolved with great speed. While precise procedures have been developed to solve many problems, the engineers have opted for approximate methods in the time involved. Computers are very useful for solving problems of the kind in which a number of times like an analysis or design problem must be created in the same process, or for solving the problem with different parameters.

- In this work gable frame work were modelled by using ETABS 2018
- Different structural system were considered for modelling and analysis performance.
- By using ETABS 2018 software the modelling and analysis of all the structure system are done.
- By the analysis of EATBS (3 dimensional analysis of gable frame) computer code could be a worm that is employed. With altimative software's
- Structures of a specific range and period is alluded as the elevated structure exchange structure can be the described as either the flexural or the shear structure that transmit overpowering weights from column or walls catching up on its top and redistribute them to supporting column walls.
- The study well be carried out 3D gable frame have in a plan. Here the gable model will be analysed for conditions which are follows,
  1. Model is without damper and bracing
  2. Model is with bracing

3. Model is with damper
4. Model is with damper and bracing

- The figures shown below is subjected to uniform distributed load ,where without bracing and dampers,

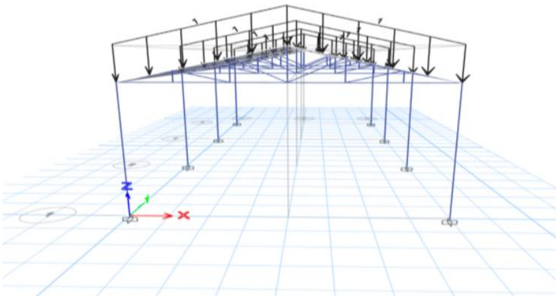

Fig4.3(a) Elevation view.

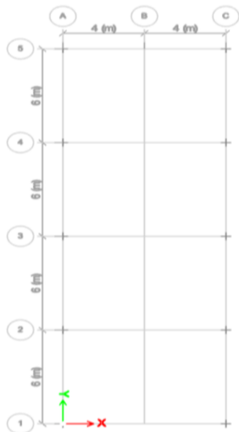

Fig4.3(b) Plan View.

- The figures shown below is subjected to uniformly distributed load with bracing, where figure

(c) Represents elevation view.

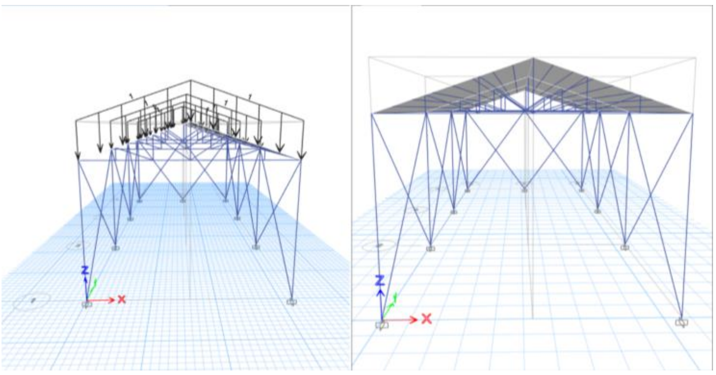

Fig4.3(c) Elevation View

- The figures shown below is subjected to uniformly distributed load with damper, where figure
  (d) Represents elevation view.

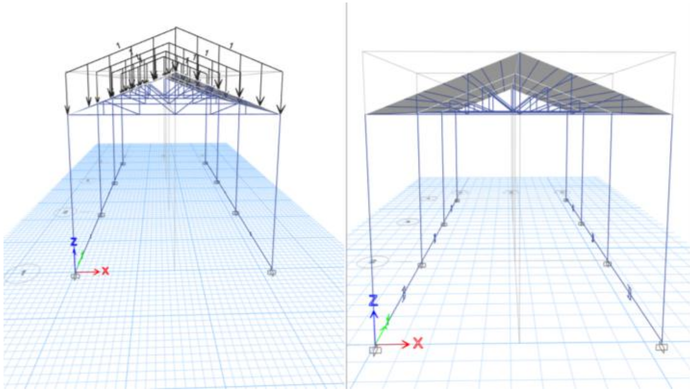

Fig4.3(d) Elevation View.

- The figures shown below is subjected to uniformly distributed load with bracing and damper, where figure

(e) Represents elevation view.

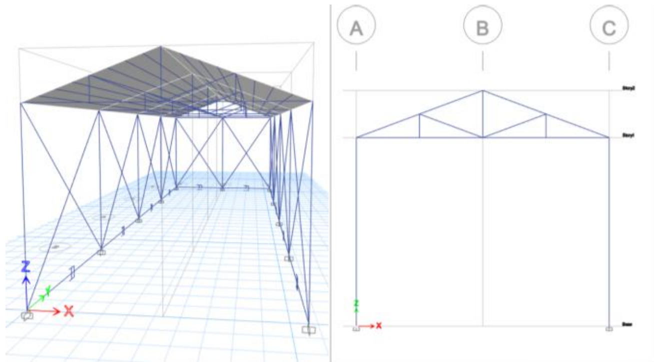

Fig4.7(e) Elevation View

4. MODEL DISCRIPTION:

The structures is analysed in ETABS software using equistatic a method for indian standards.

Geometric Details	
Plan dimensions	2066 square feet
Type of plan	Regular
Height of frame(m)	6
Rise of frame((m)	1.5
Span(m)	8
Material properties	
Grade of steel	Fe250
Min yield stress (fy)	250 Mpa
Min tensile strength (fu)	410 Mpa
Density of steel	78.5 KN/m^3
Section properties	
Slab thickness (mm)	3
Steel I/Wide Flange(mm)	600x250
Steel Tube(mm)	50x50

Web Thickness (mm)	3
Flange Thickness (mm)	3
Seismic properties	
Seismic zone (IS 1893-2002)	v
Seismic zone factor (Z)	0.36
Importance factor (I)	1.5
Response reduction factor(I)	5
Damping ratio	0.05
Link properties	FVD
Translational mass(kg)	44
Force (KN)	250

6. RESULTS AND DISCUSSION :

Performance rigid gable frame with various structures forms such as without bracing and dampers, with dampers, with bracings and with bracings and dampers, placed at different locations with deed to obtained best results for frame to sustain the loads effectively. The analysis results were compared, the most and vital structural parameters that are unit thought the comparison.

- Time Period
- Maximum Storey Displacement
- Maximum Storey Drift
- Maximum Shear Force and Bending Moment

5.1TIME PERIOD:

Modal Period-Time taken by the wave to complete one cycle is called its mode period. After modelling on ETABS following results are obtained.

Table 5.1(a) Time period various structural systems

Type of Gable Frame	Time period in seconds
Without Bracings And Dampers	0.752
With Dampers	0.561
With Bracings	0.264
With Bracings And Dampers	0.192

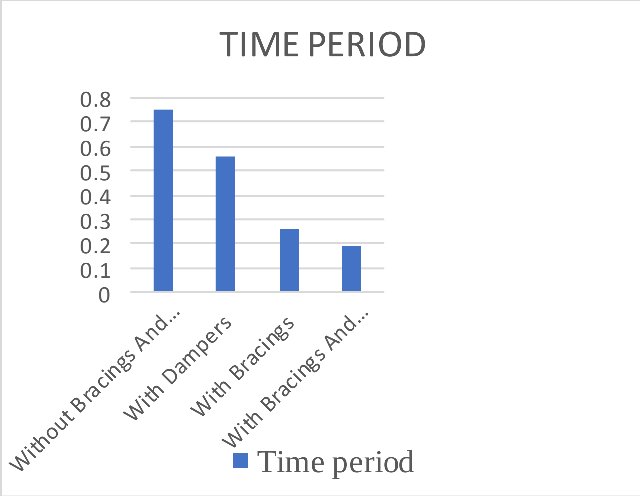

Fig 5.1 (a): Time period of all structural systems

MAXIMUM STORY DISPLACEMENT:

Story displacement is the differenced of displacements separated by the height of the story between two consecutively stories. Story displacement is the absolutely value of the storey being displaced by the lateral forces in practice. Story drift I critical in the design of partitions.

Table 5.2(a): Maximum Storey Displacement In EQx and EQy Direction.

Models	Storey	Elevation	EQx	EQy
With Out Dampers And Bracings.	Story2	7.5	0.944	16.618
	Story1	6	0.976	16.629
	Base	0	0	0
With Dampers	Story2	7.5	0.854	12.412
	Story1	6	0.887	12.423
	Base	0	0	0
With Bracings	Story2	7.5	0.758	0.061
	Story1	6	0.791	3.306
	Base	0	0	0
With Dampers And Bracings.	Story2	7.5	0.736	0.058
	Story1	6	0.768	1.692
	Base	0	0	0

Fig 5.2(a): Maximum Storey Displacement in EQx

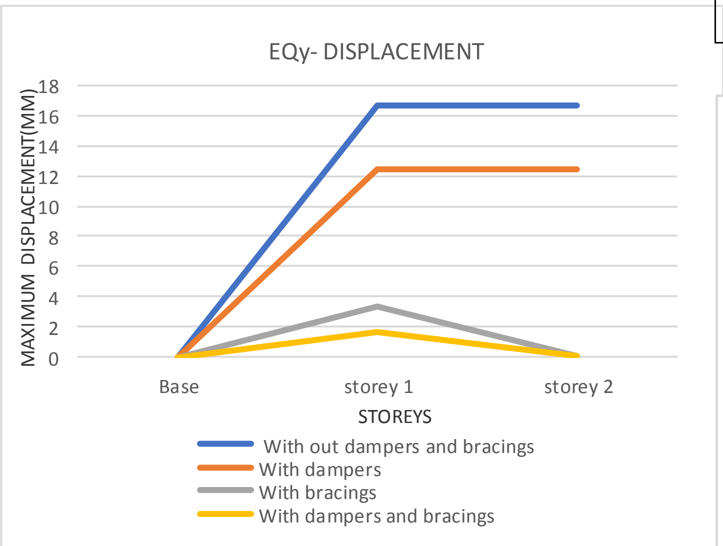

Fig 5.2(a): Maximum Storey Displacement in EQy

5.3. MAXIMUM STORY DRIFTS:

Story drift is the difference of displacements separated by the height of the story between two consecutive stories. Story displacement is the absolute value of the storey being displaced by the lateral forces in practice. Story drift critical in the design of partitions.

Table 5.3(a): Maximum Storey Drifts In EQx and EQy Direction

Models	Storey	Elevation	EQx	EQy
With Out Dampers And Bracings.	Story2	7.5	0.000007	0.00194
	Story1	6	0.000163	0.002772
	Base	0	0	0
With Dampers	Story2	7.5	0.000006	0.001695
	Story1	6	0.000148	0.00207
	Base	0	0	0
With Bracings	Story2	7.5	0.000054	0.002211
	Story1	6	0.000132	0.000551
	Base	0	0	0
With Dampers And Bracings.	Story2	7.5	0.000054	0.001137
	Story1	6	0.000128	0.000282
	Base	0	0	0

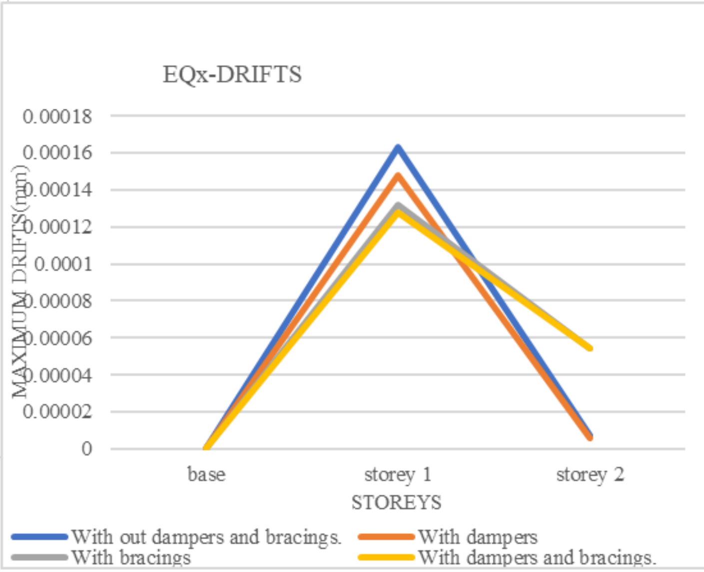

Fig 5.3(a): Maximum Storey Drifts in EQx

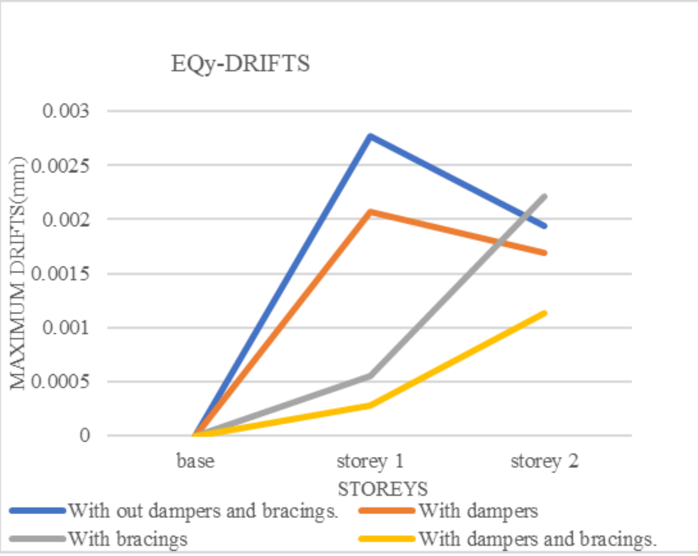

Fig 5.3(b): Maximum Storey Drifts in EQy

5.4. MAXIMUM SHEAR FORCE AND BENDING MOMENT:

- Shear force is the internal force on a member when the force is nup applied at the axis. Shearing force is the force divided by the cross sectional area.
- Bending moment is the force trying to rotate the member. Moment is the perpendicular distance from force to the axisal multiplied by the force.

Table 5.4(a): Maximum Shear force And Bending moment In EQx and EQy Direction

Models	Storey	Elevation	EQx		EQy	
			SFmax	BMmax	SFmax	BMmax
With Out Dampers And Bracings.	Story2	7.5	4.1596	17.8804	1.8759	5.8158
	Story1	6				
	Base	0				
With Dampers	Story2	7.5	3.9850	16.9514	1.7984	5.6850
	Story1	6				
	Base	0				
With Bracings	Story2	7.5	3.5011	14.8006	1.7074	5.2924
	Story1	6				
	Base	0				
With Dampers And Bracings.	Story2	7.5	3.2456	14.3650	1.6544	5.1080
	Story1	6				
	Base	0				

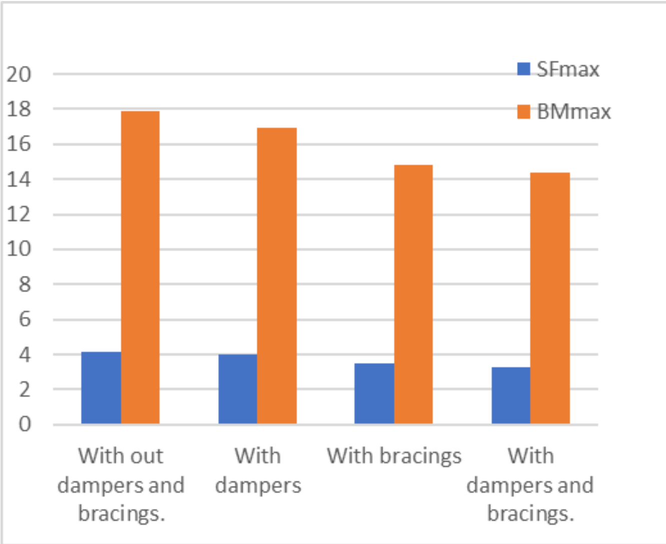

Fig 5.4(a): Maximum Shear Force And Bending Moment In EQx

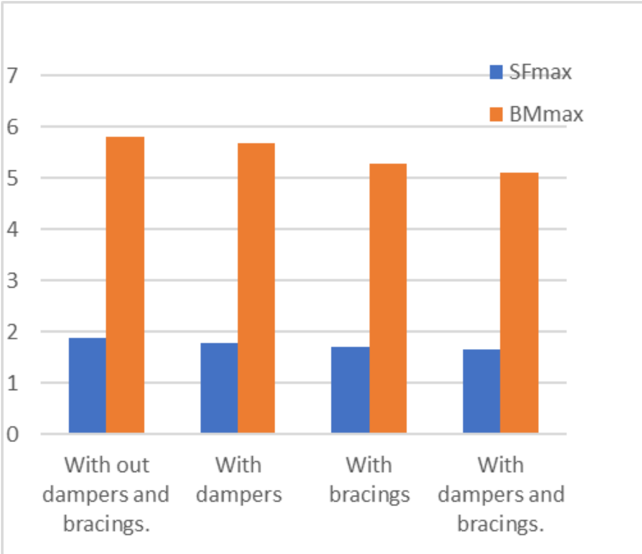

Fig 5.4(b): Maximum Shear Force And Bending Moment In EQy

6. CONCLUSIONS:

The following are the conclusions are presented based on the obtained with bracing and damper and without bracing and dampers.

- The Maximum Displacement of Gable Frame is found to be in Bare frame model i.e, 0.976mm in X-direction. With bracing and dampers model decrease the displacement to 0.768mm in X-direction. Hence there is reduction of 34% in X-direction.

- The Maximum Displacement of Gable Frame is found to be in Bare frame model i.e, 16.629mm in Y-direction. With Bracing and Dampers model decrease the displacement to 1.692mm in Y-direction. Hence there is reduction 89%in Y-direction

- The Maximum Drifts of Gable Frame is found to be in Bare frame model. With Bracing and Damper model is decrease the displacement. Hence there is reduction of 30% in X-direction.

- The Maximum Drifts of Gable Frame is found to be in Bare frame model. With Bracing and Damper model is decrease the displacement. Hence there is reduction of 88%in Y-direction.

- The MaximumShear Force and Bending Moments is found to be in Bare frame model. i.e,SFmax=4.1596KNandBMmax=17.8804KN/ Meters.WithBracingmodelisdecreasetoSFmax= 3.2456KNandBMmax=14.3650Kn/Meters. Hence there is a reduction of 30% of X-direction and 40% in Y-direction.

- From the above results we can conclude that Maximum Storey Displacement and Maximum Storey Drifts have been reduced form with Bracings and Damper Model. When compared with the Bare Frame Model, Model with Bracing and Model With Damper.

- The time period is found to be in Bare frame model i.e, 0.752 seconds. With Bracing and Dampers decrease the time period to 0.192 seconds. Hence there is reduction of 74%.

- Compered only With Dampers model and With Bracing model,with bracing model is given a good performance.

6.2. SCOPE AND LIMITATIONS:

- Symmetrical load and geometry evaluated only by gable frame.
- The gable frame subjected to uniform distributed load.
- Analysis is carried out for maximum storey drifts of dampers and bracings for gable frame.
- Analysis is carried out for maximum shear force and bending moment of dampers and bracings for gable frame.
- Analysis is carried out for maximum storey displacement of dampers and bracings for gable frame.

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