International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 12 | Dec -2020 ISSN: 2582-3930

EFFECTVE SEISMIC PERFORMANACE OF A TALL MULTISTOREY BUILDING WITH METALLIC YEILD DAMPERS (MYD) AT DIFFERENT POSITIONS IN BUILDING MODELS IN ZONE III BY USING ETABS

FAREEDA SYED[1], SANDHYA[2]
M.Tech Student[1], Department of Civil Engineering, QISIT, Ongole, A.P, India
Assistant Professor[2], Department of Civil Engineering, QISIT, Ongole, A.P, India

ABSRACT

Present scenario in the world, the trend towards skyscrapers of ever-increasing heights and the use of engineering materials as per specifications required, high strength materials, and advanced construction techniques have led to increasingly flexible and lightly damped structures and the failure potential can be minimized by counteracting vibrations. The different methods are available to control vibration in the tall buildings which increases the huge amount of strength and decreases the lateral deflection in structure. The Codes suggest that the forces and displacements of a structure are directly proportional to its height. A lot of research work is going on for reduction in responses during extreme loading condition due to wind and earthquake. The main aim of the structural engineer is to give an appropriate solution for the effects due to gravity, lateral loads, and earthquake loads. In present work, the dampers have used to minimise the deflection and shear of tall buildings at earthquake prone area in zone III. The analysis of a G+15 storey structure has been done to obtain optimum responses by using passive resistance and analysed the structure for lateral displacement, storey shear and base shear in zone III. The behaviour of tall buildings is analysed by dynamic analysis using ETABS software as per IS code of practices and done comparative study with model 1 (Bare frame), model 2 (Bare frame with damper at middle strip) and model 3 (Bare frame with damper at corners of tall building).

KEY WORDS:Metallic Yield Dampers (MYD), Compressive strength, Tensile strength, Flexural strength and ETABS software etc.

1. INTRODUCTION

The tall buildings constructed nowadays have been increased due to lack of space in smart and fast-growing cities in India. Generally, most of these buildings have a low natural damping. The control of vibrations induced in the buildings by seismic waves is achieved by modifying rigidities, masses, damping and shape or by providing passive or active counter forces.

Present work of the damper effect in the frame is an important factor for the analysis. For Analysis purpose practical (G+15) storey building modelled with and without damper by using software ETABS n zone III. Here Response spectrum analysis has performed. The result obtained from ETABS software analysis of building with and without damper are compare with each other models.

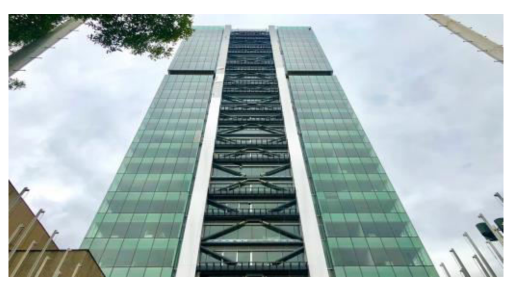

Fig 1: Typical skyscraper with dampers

a) Metallic yield dampers (MYD)-Energy dissipation devices

Metallic yield damper is relying on the principle that the metallic device deforms plastically, thus spreading vibratory energy and It is a device established in structures to minimize the frequency of mechanical vibrations. Their applications can prevent discomfort, damage, or Structural failure cause to loss of the load-carrying capacity of a component or member within a structure or of the structure itself. Structural failure is initiated when the material is stressed to its strength limit, thus causing fracture in the structures

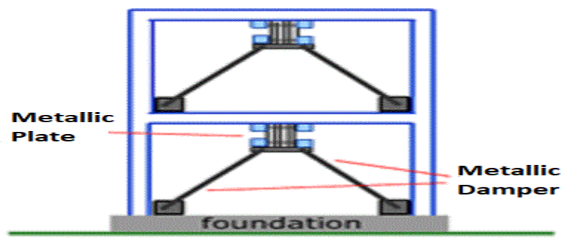

Fig 2: Metallic yield dampers

Fig 3: Typical metallic yield damper (MYD)

b) Response Spectrum Analysis (RSA)

Response spectrum analysis is defined as the plot of the peak response of a series of oscillators of varying natural frequency and amplitude that are forced into motion by the same base vibration or sudden shock and vibrations. The resulting plot can then be used to pick off the excitation of any linear system, given its natural amplitude of oscillation. One such use is in assessing the ultimate response of structure to earthquakes.Response spectrum analysis (RSA) requires that isolator units be modelled using amplitude-dependent values of effective stiffness.

c) Objective

The main objective of present work focused on the behaviour of bare frame with dampers and without dampers by considering the earthquake loading in Zone III and performed the structure by using ETABS software.

a) To perform the response spectrum analysis of tall building (G+15) frame with damper and without dampers in ETABS software.
b) To study the behaviour of building in different modes of failures from the structure
c) To study the effectiveness of metallic damper
d) Investigate the response of structure with and without MYD (Metallic Yield dampers).
e) To study various responses such as lateral displacement, storey drift and Base shear of buildings
f) Ultimately, the study of results in terms of maximum displacement, maximum storey drift, and base shear of building.
g) To study the comparative study of three models such as model 1, model 2 (Bare frame with dampers at middle strip), model 3 (Bare frame with dampers at corners)

d) Scope of the present work

The present work aims at an objective demonstrating the effect of metallic yield damper techniques for symmetric high-rise structures. The building studied in this section is G+15 storey building of concrete Special Moment Resisting Space Frames performed for gravity and Seismic loads using non-linear analysis (Dynamic analyses). The tall structure is evaluated as per seismic code IS-1893:2002 under seismic Zone III and analysis with the help of the ETABS software.

2. METHODOLOGY

a) Analytical modelling information

1. Model 1: Bare frame
2. Model 2: Bare frame with Metallic Yield Dampers (MYD) at Middle strip of tall building
3. Model 3: Bare frame with Metallic Yield Dampers (MYD) at Corner of the tall building.

b) Geometrical parameters of the practical building are as follows

According to this three-dimensional analysis is necessary for typical floor structural model for the study. Here in, method is based on simplifying assumption which determined optimum locations of belt truss. Let us the plan dimension of building and arrangements of core, outriggers, and belt truss. A lateral load is linearly increased with height of building. The model is as 25 storeys reinforced concrete consisting of frames, Core wall & outriggers.

a) Type of structure – SMRF (Special Moment Resting Frame)
b) Number of stories used - G+15, 16 Stories
c) Storey height - 3m
d) Base storey height - 3m
e) Seismic Zone – III
f) Soil type – Type II (Medium)
g) Importance factor – 1
h) Response Reduction Factor – 5
i) Seismic factor - 0.16
j) Size of concrete column - 0.30m x 0.60m
k) Size of concrete beam– 0.30m x 0.380m
l) Grade of concrete – M 25
m) Type of Dampers used – 'V' shaped Metallic yield Dampers (MYD)
n) Seismic analysis - as per S 1893-2002

c) Loads and load combinations considered

Dead load = 0.30 x 0.38 x 25 = 2.85 kN/m
Live load =2k N/m
Floor finish load = 1 kN/m
Wind load as per IS 875 part 3
Seismic load as per IS 1893 part 1
Load Combinations: load combinations for dynamic analysis

- 1.5(DL+LL)
- 1.5(DL+LL+WL)
- 1.5(DL+LL+EQL)
- 1.5(DL+LL-WL)
- 1.5(DL+LL-EQL)

d) Building description in ETABS

A bare frame of 48m height of G+ storey building and Model 1 (Bare Frame), Model 2 (Bare Frame with Metallic Yield Damper at middle strip of building) and Model 2 (Bare Frame with Metallic Yield Damper at corners of building) have been prepared and performed the seismic non-linear analysis (Dynamic analysis) in Zone III as per IS 1893-2002.

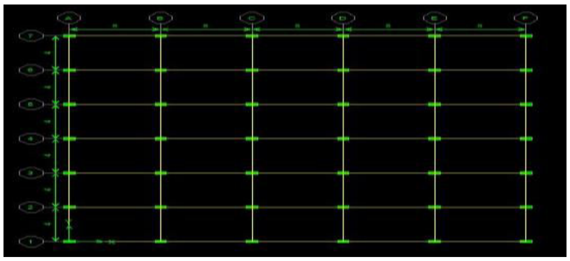

Fig 4: Plane of building

1. Model 1: Bare frame
2. Model 2: Bare frame with Metallic Yield Dampers (MYD) at Middle strip of tall building
3. Model 3: Bare frame with Metallic Yield Dampers (MYD) at Corner of the tall building

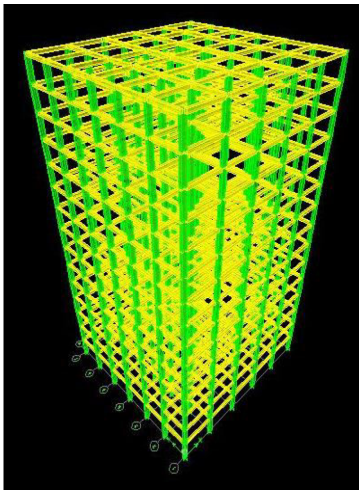

Fig 5: Model 1-3D view

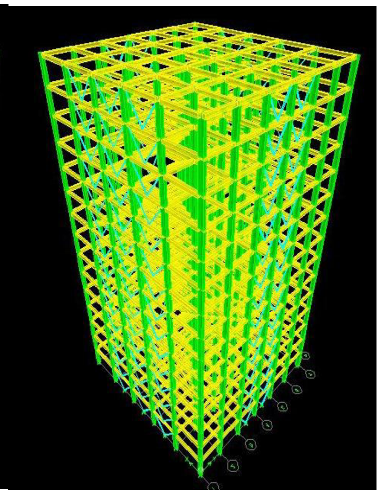

Fig 7: Model 2-3D view

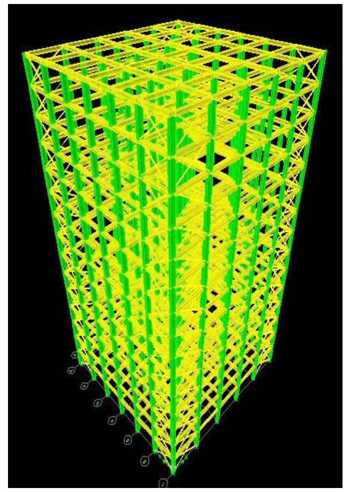

Fig 9: Model 2-3D view

3. RESULTS AND DISCUSSIONS

By analysing the various types of models in ETABS with dynamic analysis in zone III, the following results were achieved. We obtained the lateral displacements, storey drifts and base shear for analysed models for seismic effects and used the load combinations as per code practice is 1983-2002 which have been shown in below tables. And comparing the results for three models of their results with basic model i.e. Model 1 (Bare frame) in zone III. Here for Model 2 and Model 3 having the metallic yield dampers at their respective positions with proper mechanical properties for given dampers. This reduces the critical lateral displacements for seismic events and the placing of metallic damper material was kept same & the placing was changed to get position with minimum deflection.

Comparison of results for Model 1, Model 2 and Model 3 in Zone III

a) Laterla Displacements for Model 1, Model 2 and Model 3 in Zone III
b) Storey shear for Model 1, Model 2 and Model 3 in Zone III
c) Base shear for Model 1, Model 2 and Model 3 in Zone III

a) Laterla Displacements for Model 1, Model 2 and Model 3 in Zone III

Table 1: Laterla Displacements for Model 1, Model 2 and Model 3 in Zone III

S.No	Storey	Lateral displacements (m) in Model 1	Lateral displacements (m) in Model 2	Lateral displacements (m) in Model 3
1	Storey 15	0.7428	0.19	0.0115
2	Storey 14	0.7236	0.1848	0.0113
3	Storey 13	0.696	0.1776	0.011
4	Storey 12	0.6603	0.1687	0.0106
5	Storey 11	0.6177	0.1581	0.01
6	Storey 10	0.5692	0.1461	0.0094
7	Storey 9	0.516	0.1331	0.0087
8	Storey 8	0.4591	0.1193	0.0078
9	Storey 7	0.3995	0.1049	0.0069
10	Storey 6	0.3379	0.0901	0.0049
11	Storey 5	0.2752	0.0752	0.0038
12	Storey 4	0.2122	0.0604	0.0026
13	Storey 3	0.1494	0.0459	0.0015
14	Storey 2	0.0881	0.0316	0.0005

15	Storey 1	0.0321	0.0172	0.0002
16	Base Storey	0	0	0

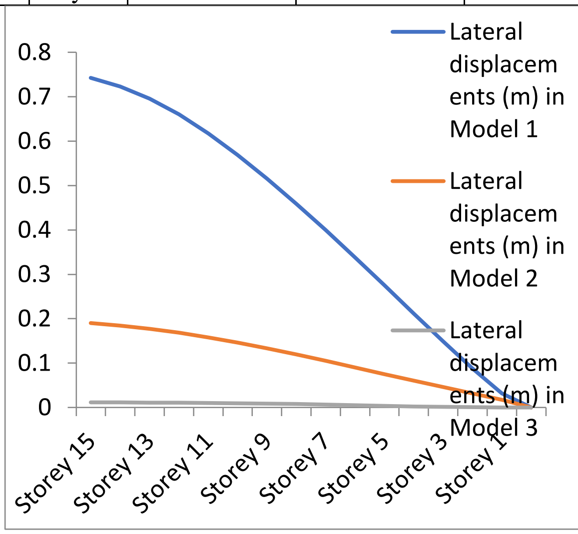

Fig 11.: Laterla Displacements for Model 1, Model 2 and Model 3 in Zone III

From figureabove figure, the analysed results obtaned by using ETABS software, here we observed that the vation of results from model to model which has the vairoaton lateral displacements and compared the results from model 1, model 2 and model 3. The lateral displacements were more in model 1 because of the model 2 having Bare frame without Dampers (MYD) in tall building, providing of the MYD at strip of tall building is necessary in case of analysis of lateral displacements. Here, we observed that, the results are compared from model 1; the model 2 is having increased about 6.2 % and model 3 is having increased about 7.8% of lateral displacement. So, there in an effect of providing the MYD at different position in building which needs to change position of providing MYD dampers in the building to minimise the lateral displacement.

b) Storey drifts for Model 1, Model 2 and Model 3 in Zone III

Table 2: Storey drifts for Model 1, Model 2 and Model 3 in Zone III

S.NO	Storey	Lateral Drifts (m) in Model 1	Lateral Drifts (m) in Model 2	Lateral Drifts (m) in Model 3
1	Storey 15	0.000075	0.000163	0.001747
2	Storey 14	0.000114	0.000234	0.002382
3	Storey 13	0.000155	0.000302	0.002995
4	Storey 12	0.000194	0.000361	0.003528
5	Storey 11	0.000229	0.00041	0.003975
6	Storey 10	0.00026	0.00045	0.004335
7	Storey 9	0.000288	0.000482	0.00461
8	Storey 8	0.000313	0.000505	0.004804
9	Storey 7	0.000335	0.000521	0.004921
10	Storey 6	0.000355	0.000531	0.004964
11	Storey 5	0.000371	0.000534	0.004939
12	Storey 4	0.000381	0.000531	0.004857
13	Storey 3	0.000376	0.000519	0.004752
14	Storey 2	0.000332	0.000475	0.004789
15	Storey 1	0.000173	0.000281	0.005743

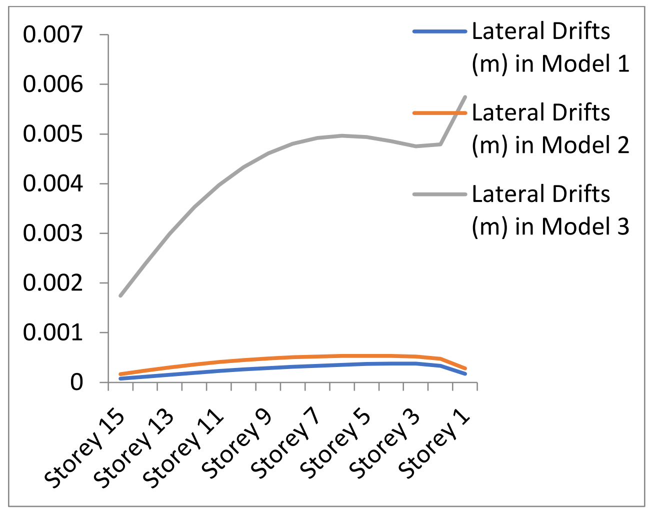

Fig 12: Storey drifts for Model 1, Model 2 and Model 3 in Zone III

From above figure, the analysed results obtaned by using ETABS software, here we observed that the vation of results from model to model which has the vairoaton lateral displacements and compared the results from model 1, model 2 and model 3. The Storey drifts were more in model 3 because of the model 3 having Bare frame with Metallic Yield Dampers (MYD) at end strip of tall building. Providing of the MYD at end strip of tall building is increases the storey drifts. So, there is an effect of providing the MYD at end strip of building. By proving damper for high rise building increases the storey drifts

c) Storey Shear for Model 1, Model 2 and Model 3 in Zone III

Table 3: Base shear for Model 1, Model 2 and Model 3 in Zone III

S.No	**Storey**	**Base shear (KN) in model 1**	**Base shear (KN) in model 2**	**Base shear (KN) in model 3**
1	Storey15	26.45	29.91	37.81
2	Storey14	55.47	81.04	80.49
3	Storey13	80.49	125.21	117.5
4	Storey12	101.8	162.6	149.61
5	Storey11	119.72	194.25	178.13
6	Storey10	134.52	220.34	203.7
7	Storey9	146.52	241.47	226.59
8	Storey8	155.99	258.16	247.3
9	Storey7	163.24	270.95	266.42
10	Storey6	168.57	280.34	283.99
11	Storey5	172.28	286.86	299.7
12	Storey4	174.64	291.03	313.31
13	Storey3	175.98	293.38	324.33
14	Storey2	176.57	294.42	331.64
15	Storey1	176.72	294.68	334.41

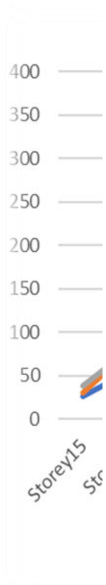

Fig 13: Base shear for Model 1, Model 2 and Model 3 in Zone III

From above figure, the analysed results obtaned by using ETABS software, here we observed that the vation of results from model to model which has the vairoaton Base shearand compared the results from model 1, model 2 and model 3. The Storey shear were more in model 2 initially after that decreases and model 3 having vice versa results as compared to model 2, because of the model 2 having Bare frame with Metallic Yield Dampers (MYD) at middle strip of tall building, providing of the MYD at middle strip of tall building is increases the storey shear. So,their effect of providing the MYD at end strip of building. And by proving dampers to the structures, minimise the stiffness of the structure and decrease the storey shear as compared to model 1.

4. CONCLUSIONS

The following conclusion can be obtained from the present study:

- The results of this dynamic analysis show that, the seismic response of building can be reduced by using metallic yield dampers. The lateral displacements are reduced about 6.2% and 7.8% as compared to model 1.
- it is observed that the lateral displacement can be reduced by substitutional number of dampers whereas displacement to be considerable.
- The metallic yield dampers are unique in combatting the earthquake forces, for its the metallic yield dampers are suitable mostly for earthquake forces only.
- By providing the metallic yield dampers, minimise the stiffness of the structure and increase the storey shear.
- The performance of metallic yield dampers is much better for tall buildings with slender design.

5. REFERENCES

1. John M. Ferritto, "economics of seismic design for new buildings", Journal of Structural Engineering, Vol. 110, No. 12, pp 2925-2938, 1985.
2. Michael Montgomery, and Constantin Christopoulos, "Experimental Validation of Viscoelastic Coupling Dampers for Enhanced Dynamic Performance of High-Rise Buildings", Journal of Structural Engineering,pp04014145-1-11, 2014.
3. NicosMakris, · G. F. Dargush,2 and M. C. Constantinou,3 Members, asce, "dynamic analysis of viscoelastic-fluid damper",journal of engineering mechanics, pp 1114-1121, 1995.
4. R. Lewandowski*, A. Bartkowiaka and H. Maciejewskia, "Dynamic analysis of frames with viscoelastic dampers: a comparison of damper models" Structural Engineering and Mechanics, Vol. 41, No. 1, pp 113-137, 2012.

5. Ri-Hui Zhang,1 and T. T. Soong,2 Member, ASCE/ seismic design of viscoelastic dampers for structural applications/ Journal of Structural Engineering, Vol. 118, No. 5, May 1992.
6. Sheng-Yung Hsu1 and Apostolos Fafltis, “seismic analysis design of frames with viscoelastic connections”, Journal of structural engineering, vol 118 no 9, pp 2459-2474, 1993.
7. WEI Wen-hui Tan Yue-hua, “Application of Viscoelastic Material in Structures Control” Journal of Wuhan University of Technology, pp91-93, 2003.
8. Xiao HUANG1,2, Hong-ping Zhu” Optimal arrangement of viscoelastic dampers for seismic control of adjacent shear-type structures”, Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering) pp 47-60, 2012.
9. X.M. Tan’, J.M.Ko’, E.H. Fang’and J.R.Qiar,”Vibration control with viscoelastic dampers in a high-rise building” ,Department of Civil & Structural Engineering The Hong Kong Polytechnic University Hung Horn, Kowloon Hong Kong. pp 935- 941,
10. Bai, J-W (2003), “Seismic retrofit for reinforced concrete building structures”, Consequence-Based Engineering (CBE) Institute Final Report, Texas A&M University.