# Comparative Study on Seismic Behavior of Different Shapes of RC Structure with Help of Viscous Damper

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**Abstract -** *In this research study is a comparative study on the different shapes of the RC building (horizontal irregularities building) by using the viscous or fluid viscous damper. There are three models in this research paper which first, the second, and the third model is H, T, and L shape respectively. These models are analyzed with the help of the ETABS software and by using IS Code 1893 part-1 2016. In this research paper, we took some seismic parameters for comparison among the models such as base shear (lateral forces at the storey due to seismic), natural period, storey stiffness, storey drift, storey overturning moment, and storey displacement. The material and geometrical properties of all models are the same such as the dimension of the beam, column, and slab. We considered the seismic zone in the fourth zone. All models are analyzed by the dynamic analysis with the help of the time history method and data of the time history is taken from "EL CENTRO" this data represents the graph of the acceleration vs. time of the earthquake e in Mexico*

***Key Words*:** Time history, fluid viscous damper, ETABS, RC building, Different shapes, horizontal irregularities.

## 1. INTRODUCTION

Energy dissipation devices are the most common component of structural passive control systems. Damping is an effect that occurs inside or on an oscillatory system that reduces, limits, or maintains its oscillations. Damping is established in physical frameworks by techniques that separate the intensity stored in the oscillation. In the simplest terms, a seismic earthquake is defined as shaking and vibration on the surface of the earth caused by subsurface growth along a flat plane. Tremors are caused by seismic waves, which induce vibrations. Seismic waves are the most tragic. [1] The recent advancement in the use of passive energy absorption technologies for structural earthquake resistance. In a shaking table, multi-story scale model building structures are evaluated and subjected to a semi-active fluid damper control system. [3] The seismic effect of an 8-story RC building seismic energy dissipation device application in China is viscous damper, visco-elastic damper, and steel damper. [4] High-capacity friction dampers based on the rotating friction principle are installed in tall constructions. [5] Frictional dampers in single-story constructions prevent seismic action. [6] The seismic response of a viscous damper is calculated using complicated damper theory. [7] To manage shock vibration, seismic vibration may be controlled by using fluid viscous dampers. Viscous damper mathematical modelling and dynamic analysis.

The maintenance and application of any structure are thus jeopardised as the population grows. A quake-safe structure, according to conventional norms, can withstand the most severe shaking that might occur in that specific zone. Regardless, the most effective technique for designing a shaking secure structure is to restrict the passing as well as the decimation of the fundamental component's functionality. From historical and recent records, the world has seen several devastating seismic earthquakes, increasing the number of people killed as a result of basic crumples and severe structural damage.

### 1.1 Viscous Damper

The viscous damper is defined as the hydraulic device which dissipates the kinetic energy of the earthquake which acts on the building. The principle of the viscous damper (fluid viscous damper) is based on the hydraulic device which increases the period of the seismic force acting on the structure. The figure of the viscous damper is given below:

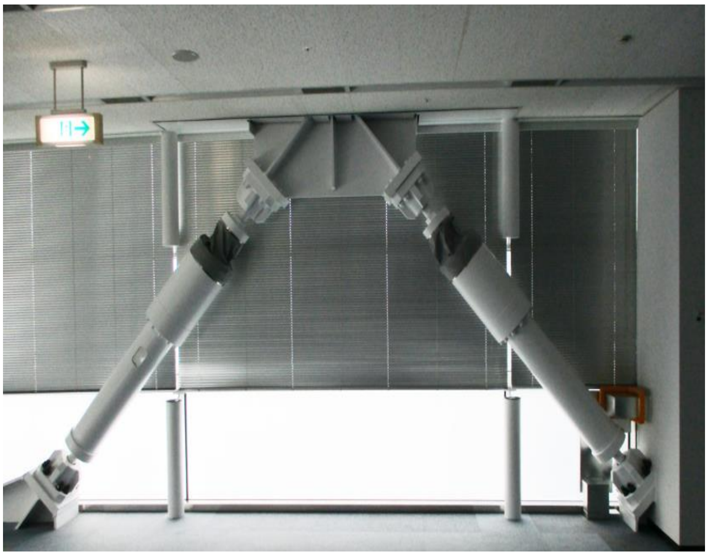

**Figure -01: Fluid Viscous Damper**

In the following figure, the parameter of the fluid viscous damper is given below and we take the fluid viscous damper whose force is 500KN and mass is 98Kg in the model:

FVD with Different Capacities Force(kN).

| FORCE (kN) | TAYLOR DEVICES MODEL NUMBER | SPHERICAL BEARING BORE DIAMETER (mm) | MID-STROKE LENGTH (mm) | STROKE (mm) | CLEVIS THICKNESS (mm) | MAXIMUM CLEVIS WIDTH (mm) | CLEVIS DEPTH (mm) | BEARING THICKNESS (mm) | MAXIMUM CYLINDER DIAMETER (mm) | WEIGHT (kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| 250 | 17120 | 38.10 | 787 | ±75 | 43 | 100 | 83 | 33 | 114 | 44 |
| 500 | 17130 | 50.80 | 997 | ±100 | 55 | 127 | 102 | 44 | 150 | 98 |
| 750 | 17140 | 57.15 | 1016 | ±100 | 59 | 155 | 129 | 50 | 184 | 168 |
| 1000 | 17150 | 69.85 | 1048 | ±100 | 71 | 185 | 150 | 61 | 210 | 254 |
| 1500 | 17160 | 76.20 | 1105 | ±100 | 77 | 205 | 162 | 67 | 241 | 306 |
| 2000 | 17170 | 88.90 | 1346 | ±125 | 91 | 230 | 191 | 78 | 286 | 500 |
| 3000 | 17180 | 101.60 | 1441 | ±125 | 117 | 290 | 203 | 89 | 350 | 800 |
| 4000 | 17190 | 127.00 | 1645 | ±125 | 142 | 325 | 273 | 111 | 425 | 1088 |
| 6500 | 17200 | 152.40 | 1752 | ±125 | 154 | 350 | 305 | 121 | 515 | 1930 |
| 8000 | 17210 | 177.80 | 1867 | ±125 | 178 | 415 | 317 | 135 | 565 | 2625 |

**Figure -02: Property of Fluid Viscous Damper**

## 1.2 Horizontal Irregularities

According to the IS Code 1893 part-1 2016, from clause 7.1, irregular configuration is given in different conditions such as "Torsional irregularities, and re-entrant corner. All models in this paper are comes under the horizontal (plan) irregularities, where the re-entrant corner is present in every model.

## 2. METHODOLOGY

In this paper, we used the time history method for the analysis of all models by using the Etabs software, also the vertical load combination according to the IS code 1893 part-1: 2016 from clause number 6.3.4.1.

## 2.1 Dynamic Analysis Method

This method is also known as the Time history method, and this method is used when the variation of the forces concerning the time was high .and in this method we provided the data of time history "EL CENTRO", The 1940 "*EL CENTRO*" earthquake Southern California near the international border of the United States and Mexico and the magnitude was 6.9.

## 2.2 Property of Fluid Viscous Damper

The viscous damper which is used in this model to decrease the storey displacement and some other seismic parameter which act on the structure is given below in the form of the table:

**Table -1:** Parameter of FVD

| Force (KN) | Taylor Device model number | Maximum cylinder Diameter (mm) | Weight (Kg) |
|---|---|---|---|
| 500 | 17120 | 114 | 44 |

## 3. DETAILS OF MODEL

In the model details, we will give and discuss the parameter of the building, seismic parameters, and load and material parameters.

## 3.1 Material Parameter

In this parameter, we give the details about the material which is used in the building and the material parameter is given below in the table:

**Table -2:** Material Parameter

| S. No | Material | Grade |
|---|---|---|
| 01. | Concrete | M30 |
| 02. | HYSD Steel | Fe415 |
| 03. | Mild Steel | Fe250 |

## 3.2 Building Parameter

In this parameter, we give the details about building parameters such as the size of beam, column and slab is given below in the table:

**Table -3:** Building Parameter

| S.No | Building Parameter | Value |
|---|---|---|
| 01. | Beam | 300mm 450mm |
| 02. | Column | 350mm 500mm |
| 03. | Slab | 150mm |
| 04. | Span of Beam | 3.5 m |
| 05. | Height of building | 48.5m |
| 06. | Floor height | 3m |
| 07. | Ground storey | 3.5m |

### 3.3 Seismic Parameter

In this parameter, we are given the parameter of the seismic where the model is assumed to construct such as seismic zone factor, Importance factor, etc

**Table -4:** Seismic Parameter

| S.No | Seismic Parameter | Value |
|---|---|---|
| 01. | Seismic Zone Factor (Z) | 0.24 ( Forth Zone) |
| 02. | Response Reduction Factor (R) | 5 |
| 03. | Importance factor (I) | 1.2 |
| 04. | Soil type | 2nd |
| 05. | Eccentric ratio | 5% |

### 3.4 Load Parameter

The load which is acting on the structure such as Imposed load, Seismic load, etc is given in the table:

**Table -5:** Load Parameter

| S.No | Load Parameter | Value |
|---|---|---|
| 01. | Live load | 3KN/m² |
| 02. | Partition wall | 7KN/m |
| 03. | Load distribution wall | 14KN/m |

### 3.5 Plan, Elevation and 3D of Model-01

The plan, elevation and three-dimensional view of the model-01 are given below:

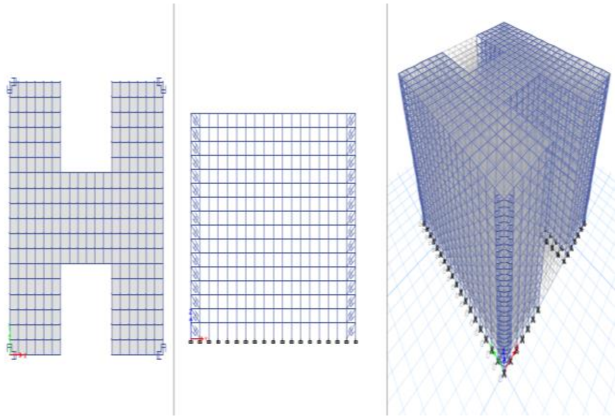

**Figure -03**: Plan, Elevation and 3D view of Model-01

### 3.6 Plan, Elevation and 3D of Model-02

The plan, elevation and three-dimensional view of the model-02 are given below:

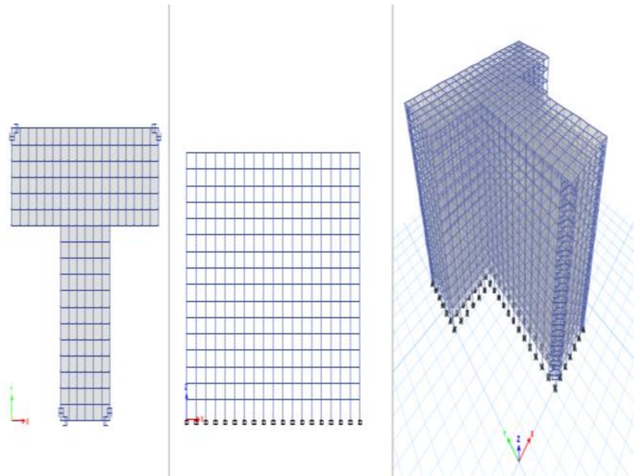

**Figure -04**: Plan, Elevation and 3D view of Model-02

### 3.7 Plan, Elevation and 3D of Model-03

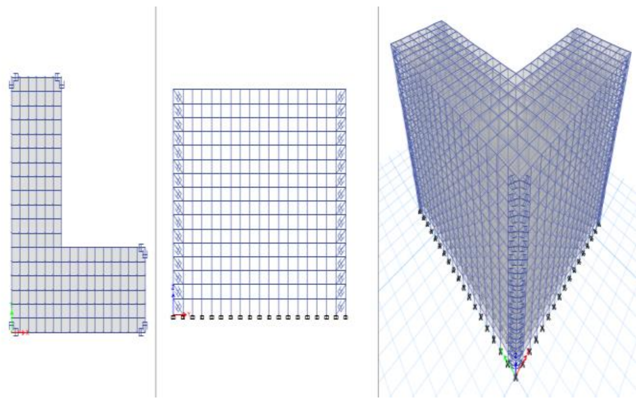

**Figure -05**: Plan, Elevation and 3D view of Model-03

## 4. CALCULATION AND RESULT

In this chapter, we analyze the result which came after the analysis of this entire model, we take some parameters of the seismic such as natural period, base shear, storey displacement, storey stiffness, storey drift, etc. based on these parameters we will check that which shape of the model is more stable as compared to other two models.

### 4.1 Natural Period

From clause 3.18 from Indian Standard Code 1893 part-1:2016, the natural period in the mode of oscillation is defined as the time (in a sec) taken by structure to complete one rotation of the oscillation in its natural mode of wavering. The following graph represents the variation of the natural period:

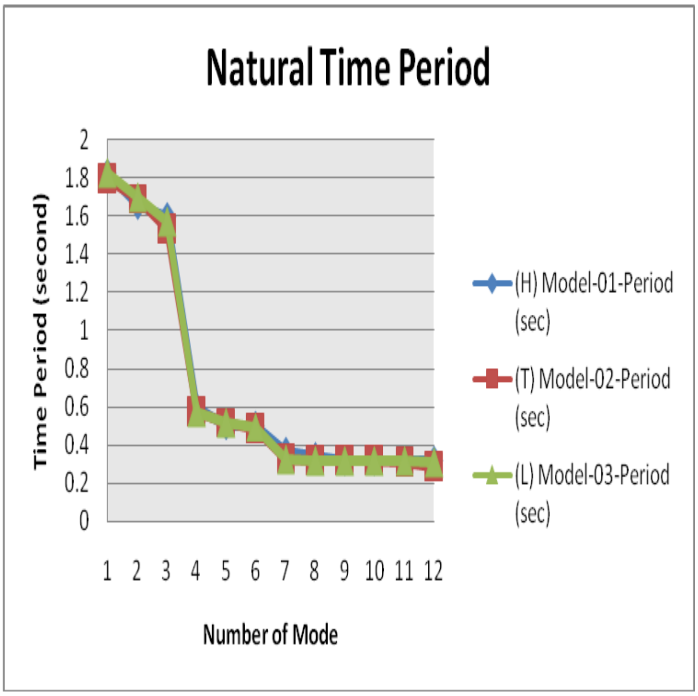


**Chart -01**: Natural Period

Concerning the Indian Standradrad code 1893 part-1:2016, the natural period of RCC structure should exist in 0.05 to 2.00 seconds.

### 4.2 Base Shear

From clause 7.2.1, from Indian Standard code 1893 part-1: 2016, the base shear is defined as the lateral forces which act at every storey due to seismic effect on the structure.
The following graph represents the base shear (lateral forces) of all models in the X direction due to applying seismic effect in the Y direction:

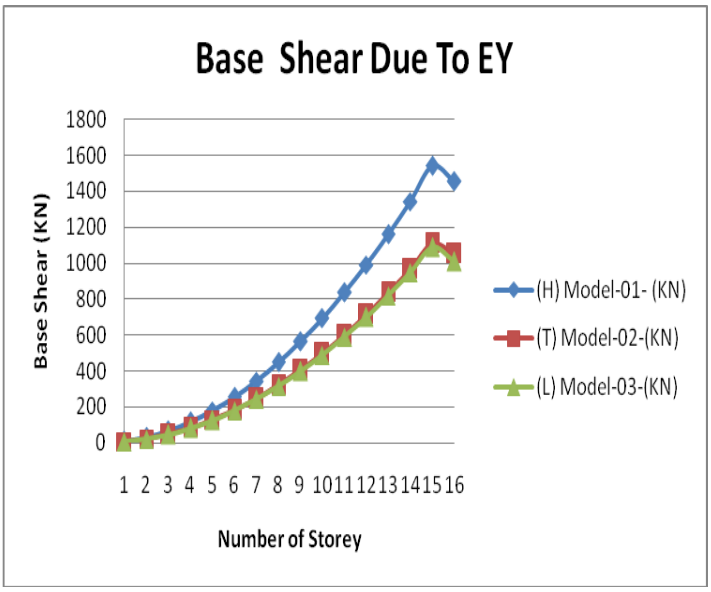


**Chart -02**: Base Shear Due to EY

From the above graph, we can see that the value of the base shear is maximum in the H shape building.

### 4.3 Maximum Storey Displacement

It is defined as the displacement of every storey concerning the ground which is developed due to the effect of the seismic forces on the structure

The graph of the maximum storey displacement is given below for all models:

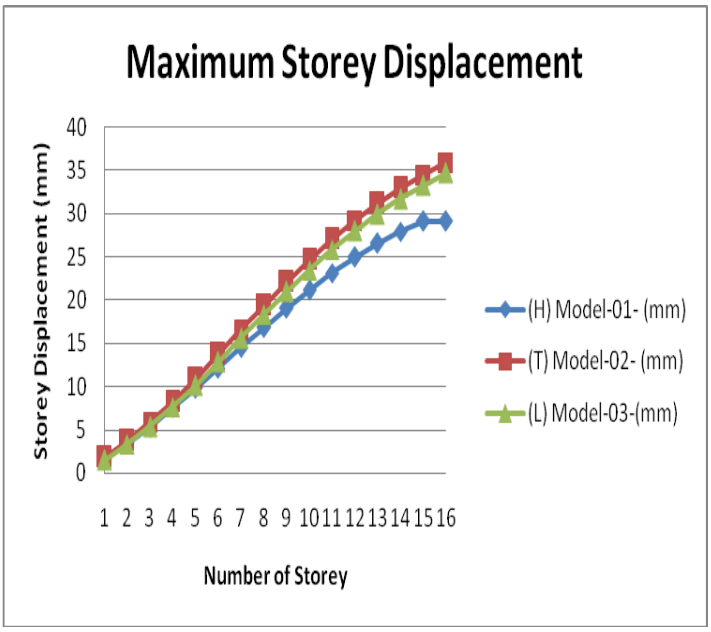


**Chart -03**: Maximum Storey Displacement

From the above graph, we can see the value of maximum storey displacement in the T shape building.

### 4.4 Storey Drift

Storey Drift is defined as the relative displacement of the storey concerning the top or below the storey. Storey drift does not calculate concerning the ground surface.

The graph of the storey drift of all models is given in the form of the graph:

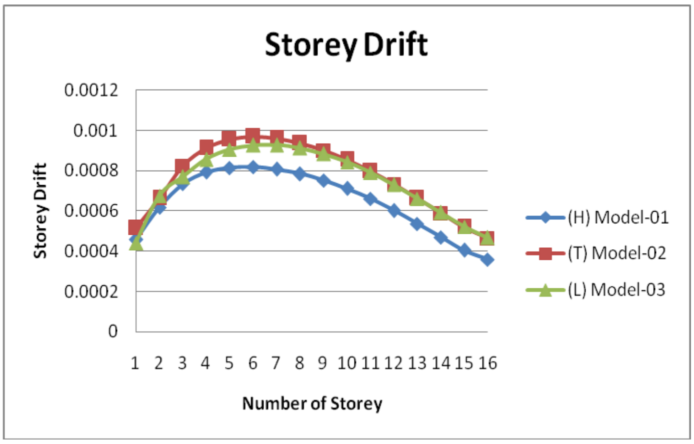


**Chart -04**: Storey Drift

Concerning the Indian Standard code, the because of storey drift should not exceed 0.004 height of the floor.

### 4.5 Storey Stiffness

Storey stiffness is defined by Indian standard code 1893 part-1:2016, it is the ratio of the storey shear to the storey drift.

The graph of the storey stiffness of all models is given below:

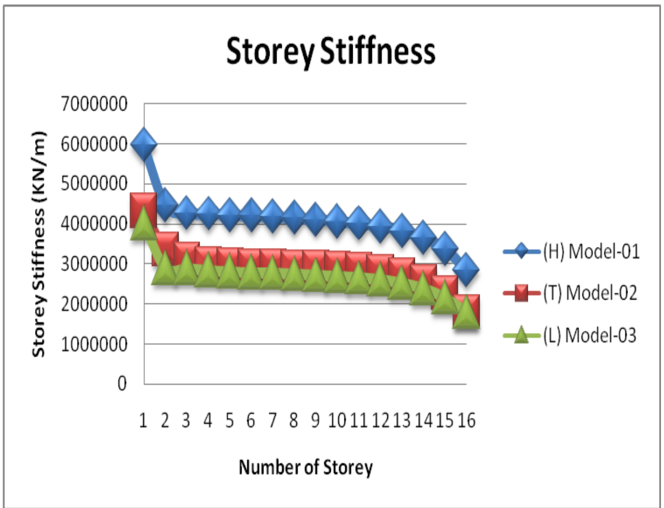


**Chart -05**: Storey Stiffness

From the above graph, we can see that the value of the story stiffness is high in the H shape building.

## 5. CONCLUSIONS

There are three models in this paper (H, T and L) and these models are linked with the fluid viscous damper, and analysis there models we found some conclusion which is given below:

i. From the graph of the base shear due to EY, we can see that the value of the base shear is minimum in the model-03 because the dead load is low in the model-03 as compared to the other two models (H and T) and imposed load is constant in these three models.

ii. From the graph of the maximum storey displacement, we can see that the storey displacement of the model-01(H) is low as compared to another two models (T and L), because the H shape is supported from everywhere, and it can easily transfer the lateral load in the all direction, wherein another two models it is difficult to transfer.

iii. According to the Indian Standard Code, if an RCC Building has floor one to 20 then the natural period should exist from 0.005 to 2.00second, with this reference all model is in the safe. The value of the natural time of model-02 is 1.86 % less as compared to model-01 and 1.54% less as compared to model-02.

iv. The value of the storey stiffness of the model-03(L) is low as compared to the two models. The value of the storey stiffness of model-03 is 32.82% less than model-01 and 7.18% less than as compared to model-02.

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