# MATlab Code for Economical Seismic design of Irregular Building

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**Abstract -** *Irregular structure such as 'cruciform' shape in plane has sustained a significant damage due to formation of re-entrant corners. Constructing these type of structure results in heavy resources. So in this paper we were aimed to determine an economical way for this type of structure. The analytical process has been carried out in MATlab & SAP2000. By comparing different type of analysis we came know that Building with Shear wall & Viscous damper Results in economic structure.*

***Key Words*: *Seismic Design, Irregular Building, Response Spectrum analysis, Viscous Damper, Tuned Mass Damper, Friction Isolation.***

## 1. INTRODUCTION

A desire to create an aesthetic and functionally efficient structure drives architects to conceive wonderful and imaginative structures. Most of the structures categorized as irregular structures. The building which lack symmetry & has discontinuity in geometry, mass or load resisting elements is known as irregular building. Plan Irregularity is most commonly found in irregular structures. These Plan irregularities are due to re-entrant corners & Torsion effect. For the shapes like L, T, H, + has lack of tensile capacity & force concentration which in returns tends to re-entrant corners [1]. In simple we can say these types of building wings behave differently when they undergo seismic loading as shown in Fig 1.

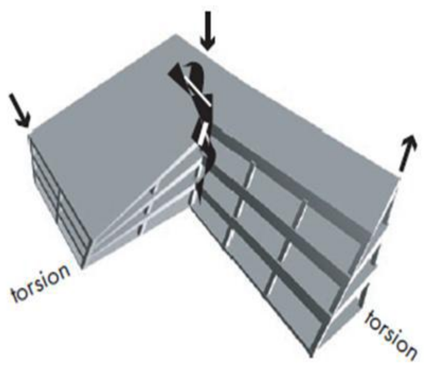


**Fig -1**: Problems Caused by a Building with Re-entrant corners

Rucha Banginwar, M R Vyawahare, P Modani explains that the behavior of building during earthquake depends critically on its overall shape, size and geometry [2]. Sai pradeep.p, Dr.S.Elavenil described the behavior of different plan during seismic events using Staad pro [3]. Himanshu Bansal, Gagandeep carried out Response spectrum analysis (RSA) for different irregularities & described their behavior [4]. Divyashree M and Gopi Siddappa 's illustrated work shows us that by introducing shear walls & bracings we can minimise the effect [5]. Anshuman.S, Dipendu Bhunia and Bhavin Ramjiyani has made a point on the loaction of shear walls whihc helps in reduction of seismic effect [6]. N.Torunbalci1 and G.Ozpalanlar has illustrated their work on base isolation & explained how it can be used to reduce the earthquake forces [7].

## 2. METHODOLOGY

In this paper the analysis was carried out in two parts. Firstly, we carried out analytical part of structure by writing code in matlab. This again was divided into four parts. In first part we have carried out Response spectrum analysis & Base shear has been obtained. In second part we have written code for stiffness matrix which analyzed structure & bending moment, Shear force has been obtained. In the third part we have applied load combinations & in final part we have merged Sap2000 for Design. As time was inconsistent the further process was done in SAP2000. Secondly, the structure was analysed with Dampers, Isolators & Shear walls. Finally, we have compared the results.

## 3. ANALYTICAL MODELLING

### 3.1 Design Data

Building Dimensions = 21m x 15 m
Young's modulus of (M25) Concrete, Ec = 25000 N/m$^2$
Young's modulus of Steel, Es = 2 x $10^{11}$ N/m$^2$
Density of Steel = Fe415
Type of Structure = Special Moment Resisting Frame (SMRF)
No. of floors in all models = G+11
Type of Building = General Building
Storey Height = 3.0 m
Seismic Zone = III
Thickness of Slab = 0.15m
Column size for all model buildings = (0.45m x 0.45m)
Beam dimensions for all model buildings = (0.23mx0.45m)
Thickness of wall = 0.230m
Live load on floors = 4 kN/m2

Wall load of 230mm thick = 13.625 KN/m
Zone factor (III) = 0.16
Importance Factor (I) = 1.0
Response Reduction Factor (R) = 5
Type of Soil = II (For medium soil types)
Fundamental Natural period
In X-Direction – 0.707 sec
In Y-Direction – 0.852 sec

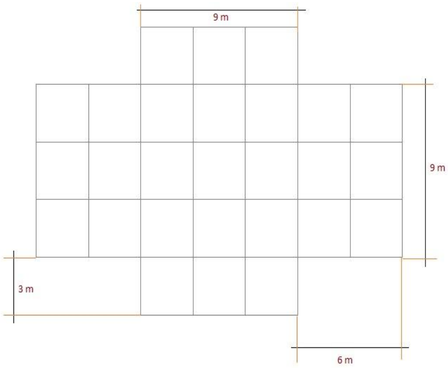


**Fig -2**: Plan of Irregular Structure

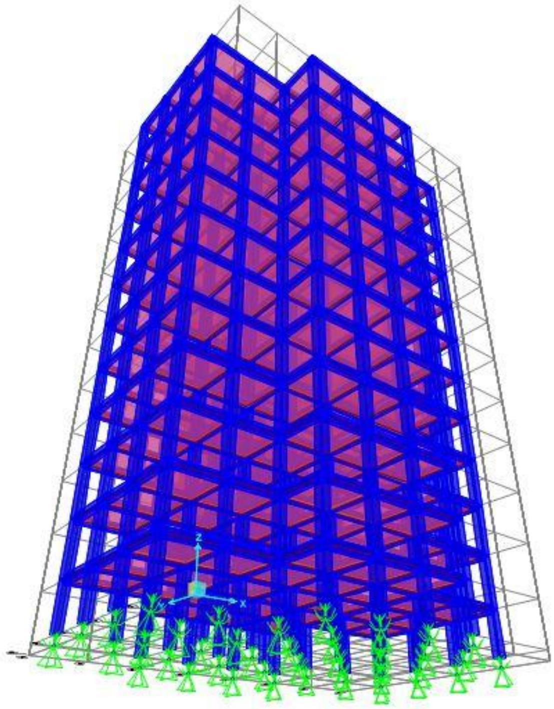

**Fig -4**: Friction Isolated model in Sap2000

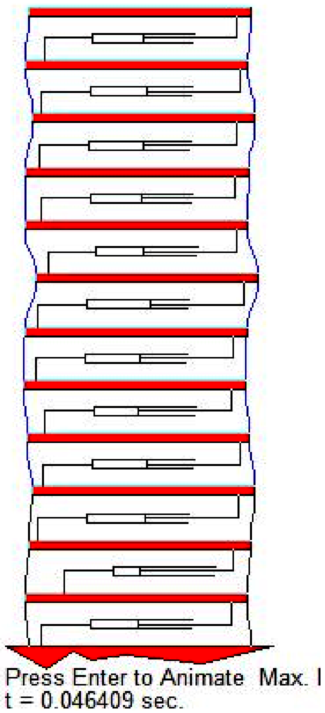


**Fig -3**: Model of Structure in MATlab during Modal analysis

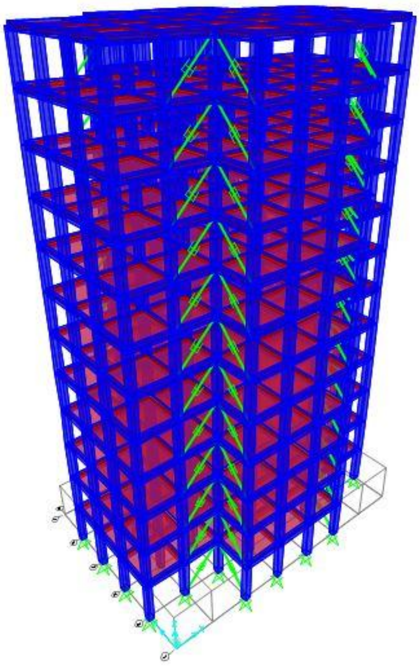

**Fig -5**: Viscous Damper Model in Sap2000

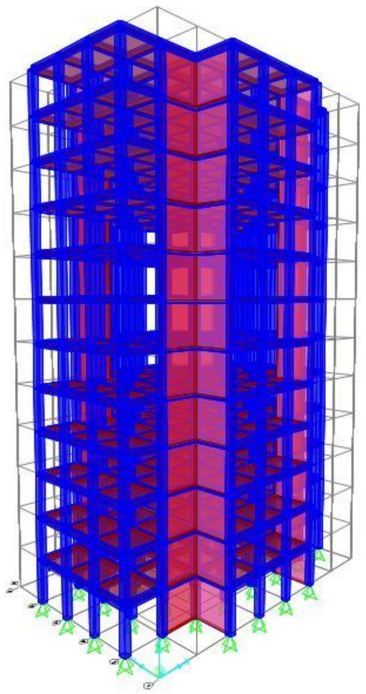

**Fig -6**: Shear Wall Model in Sap2000

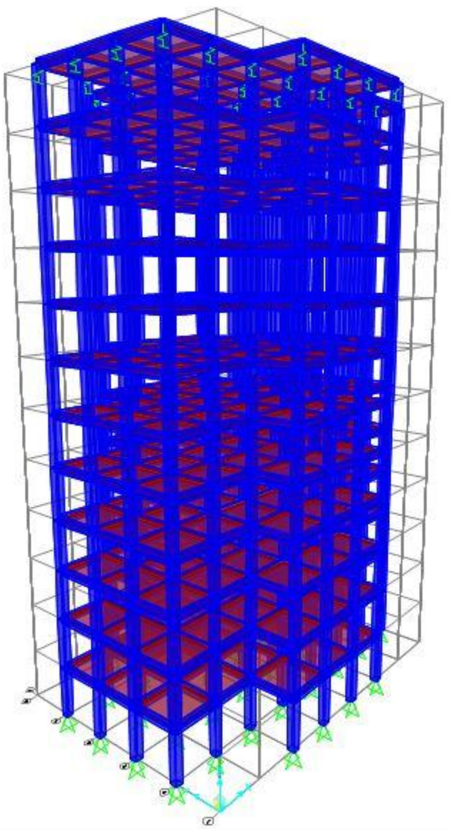

**Fig -7**: Tuned Mass Model In Sap2000

### 4. Results and discussions

The following parameters of the results obtained from analysis are considered for the study.

### 4.1 Base shear

On analysis of all Models i.e normal structure, viscous damper, Friction isolation, Shear wall, Tuned Mass damper, the base shears obtained is tabulated in Table 1.

**Table -1:** Comparison of Base shear (KN)

| Comparison of Base Shear | | |
|---|---|---|
| Description | X- Direction | Y- Direction |
| Normal Structure (M1) | 3972 | 3872 |
| With Friction Isolation (M2) | 2545 | 2325 |
| With Viscous Damper (M3) | 3280 | 3201 |
| With Tuned Mass Damper (M4) | 2302 | 2000 |
| With Shear Wall (M5) | 3082 | 2973 |

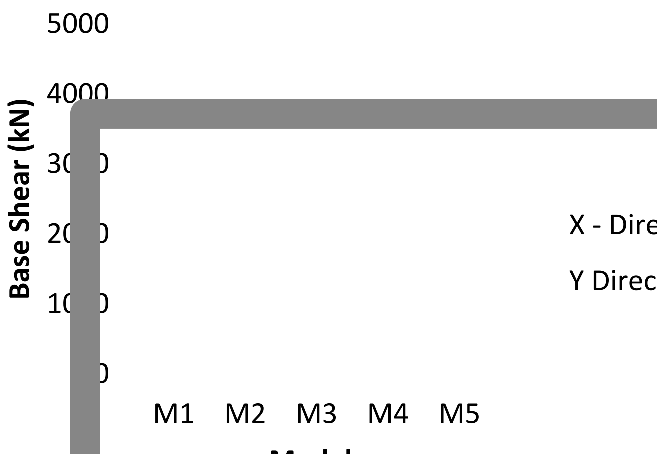


**Chart -1**: Comparison of Base Shear

### 4.2 STOREY DRIFTS

The permissible inter storey drift is limited to 0.004 times the storey height, so that minimum damage would take place during earthquake and pose less psychological fear in the minds of people. The maximum storey drifts of different models are shown in Tables 2 & Table 3.

**Table -2:** Comparison of Storey Drifts (mm)

| Storey | M-1 | M-3 | M-4 | M-5 |
|---|---|---|---|---|
| 1 | 3 | 3 | 1 | 3.9 |
| 2 | 6 | 8 | 1 | 5.5 |
| 3 | 7 | 8 | 1 | 6.8 |

**Table -3:** Comparison of Storey Drifts (mm)

| Storey | M-1 | M-3 | M-4 | M-5 |
|---|---|---|---|---|
| 4 | 10 | 8 | 4 | 7.7 |
| 5 | 11 | 8 | 12 | 8.3 |
| 6 | 13 | 10 | 10 | 8.5 |
| 7 | 15 | 10 | 10 | 8.4 |
| 8 | 15 | 11 | 11 | 8 |
| 9 | 17 | 6 | 6 | 7.3 |
| 10 | 18 | 6 | 10 | 6.2 |
| 11 | 21 | 12 | 10 | 5.4 |

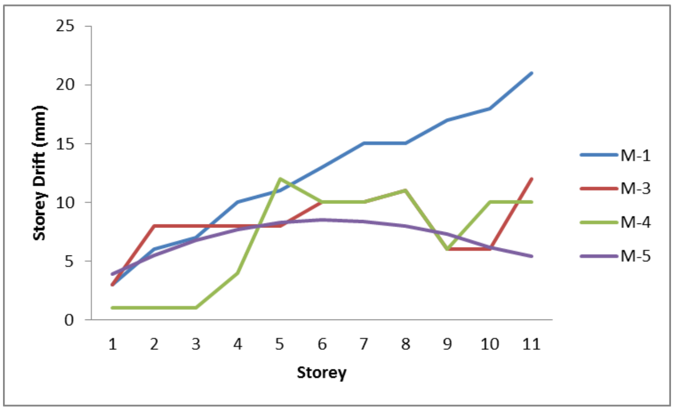


**Chart -2**: Comparison of Storey Drift

### 4.2 Shear Force & Bending Moments

Maximum Shear force & Maximum Bending moments are shown in Table 4 & Table 5

**Table -4:** Comparison of maximum Shear force & Bending moment at Bottom storey

| Models | Maximum Shear force (kN) | Maximum Bending Moments (kNm) |
|---|---|---|
| M-1 | 272 | 817 |
| M-2 | 201 | 233 |
| M-3 | 180 | 539 |
| M-4 | 254 | 764 |
| M-5 | 50 | 147 |

**Table -5:** Comparison of maximum Shear force & bending moment at Top storey

| Models | Maximum Shear force (kN) | Maximum Bending Moments (kNm) |
|---|---|---|
| M-1 | 56 | 99 |
| M-2 | 24 | 15 |
| M-3 | 37 | 66 |
| M-4 | 86 | 137 |
| M-5 | 185 | 305 |

## 5. CONCLUSIONS

From the results we can see that, by providing shear wall in support to re-entrant corners can reduce the Storey drift by 70 % as well as bending moment & shear force by 80%. But in cost point of view it won't be economical. Alternate to that viscous damper can also reduce the Storey drift by 40%, bending moment & shear force by 30%. We can also consider tuned Mass damper which will reduce drift by 50% and Bending moment & Shear force by 10% .

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