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# STUDY OF DYNAMIC RESISTANCE OF RC BUILDING BY USING TUNED MASS DAMPERS

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***Abstract - This paper shows that G + 26 story structures with Plan irregularity of 3 Equal height of the structure system with and without STMD and MTMD for structural. The Design Procedure has elaborated and the storey displacement, storey drifts, base shear, storey shear and time period will be studied with comparison of optimum position of mass. Finally concluding remarks has been highlighted.***

***Keywords- Tuned Mass Damper, Multiple Tuned Mass Dampers, Vibration Control Device, Mass Ratio, Natural Time Period, Etabs***

## I. INTRODUCTION

Earthquake may be defined as a wave like motion generated by forces in constant turmoil under the surface layer of the earth (lithosphere), travelling through the earth's crust. It may also be defined as the vibration, sometimes violent, of the earth's surface as a result of a release of energy in the earth's crust. This release of energy can cause by sudden dislocations of segments of the crust, volcanic eruption, or even explosion created by humans. Dislocations of crust segments, however, lead to the most destructive quakes. **Tuned mass dampers (TMD)** have been widely used for vibration control in mechanical engineering systems. In recent years, TMD theory has been adopted to reduce vibrations of tall buildings and other civil engineering structures.TMD is attached to a structure in order to reduce the dynamic response of the structure. The frequency of the damper is tuned to a particular structural frequency so that when that frequency is excited, the damper will resonate out of phase with the structural motion. The mass is usually attached to the building via a spring-dashpot system and energy is dissipated by the dashpot as relative motion develops between the mass and the structure. The concept of the tuned mass damper (TMD) dates back to the 1940s (Den Hartog 1947). It consists of a secondary mass with properly tuned spring and damping elements, providing a frequency-dependent hysteresis that increases damping in the primary structure. The success of such a system in reducing wind-excited structural vibrations is now well established. Recently, numerical and experimental studies have been carried out on the effectiveness of TMDs in reducing seismic response of structures (for instance, Villaverde (1994).The first structure in which tuned mass damper was installed is the Centre point Tower in Sydney, Australia. Tuned mass damper is attached to a vibrating structure to reduce undesirable vibrations. Tuned mass damper is a passive energy absorbing device consisting of a mass, a spring and a viscous damper.

**The aim of the present study of G + 26 story structure with Plan irregularity of 3 Equal height of the structure system with and without STMD and MTMD for structural**

## II. LITERATURE REVIEW

**Fredy Picauly, Hrc. Priyosulistyo[1]** are used a passive damper system named tuned mass damper with additional "X – Shaped Metal" absorber as an additional damper which was applied to the concrete slab having a dimension of 4 m in length, 0.90m in width and 0.08m in thickness. Result obtained TMD system will be able to reduce the vibration when TMD frequency is set to near about structure frequency. With the TMD mass ratio of 2.0%, the TMD is able to reduce the amplitude of the main system (slab) from 18.68 mm to 0.68 mm at the original natural frequency, but it stimulates additional amplitudes of 12.93 mm at its surroundings.

**Dr. Mohan M. Murudi, Mr. Sharadchandra M. Mane[2]** the effectiveness of TMD in controlling the seismic response of structures and the influence of various ground motion parameters on the seismic effectiveness of TMD have been investigated. Result obtained TMD is effective for controlling structural response to harmonic base excitation.TMD is most effective for lightly damped structure, and its effectiveness decreases as with increase in structural damping. TMD is more effective for long duration earthquake ground motions.

**H. R. Owji, A Hossain Nezhad Shirazi[3]** the behavior of a structure equipped with a new type of semiactive tuned mass damper called SADA-TMD is compared to the behavior of a structure equipped with active tuned mass damper

(ATMD).result obtained In this paper the effects of SADA-TMD to control the structural vibration was compared with the effects of ATMD. It is clear that active actuators needs high amount of power to produce required force to control structural vibration but SADA needs only a power source like power of a battery, so it is more reliable than active actuator during sever earthquakes. Finding a method to calculate optimal amount of SADA-TMD characteristics or improvement the fuzzy logic controller characteristics can be done in future works. Finding another rule to determine the activation time in order to raise the effects of SADATMD also is a matter of interest.

**Tharwat A. Sakr[4]** an innovative technique for using partial floor loads as multiple TMDs at limited number of floors. This technique eliminates complications resulting from the addition of huge masses required for response control and maintains the mass of the original structure without any added loads. The effects of using partial loads of limited floors starting from the top as TMDs on the vibration response of buildings to wind and earthquakes are investigated. Result obtained The existence of multiple-story TMDs significantly reduces the drift, acceleration, and force response of all examined buildings subjected to sinusoidal dynamic loads. An increase in $q^i$ and the number of stories utilized as TMDs significantly enhances the response of all types of buildings to sinusoidal loads.

**Yoyong Arfiadi[5]** the optimization of composite tuned mass dampers in reducing the response of structures subject to earthquake are discussed. Composite tuned mass dampers are mass dampers that consist of two mass dampers connected in series.result obtained It is found that the ratio of auxiliary mass to the total mass of damper does not affect significantly the response of the structure. It is also possible that the optimum parameters of the dampers are not unique for a certain mass ratio of dampers.

**Z. Guenidi, M. Abdeddaim[6]** the responses of the two buildings are controlled by using two strategies: i) a shared tuned mass damper (TMD) ii) a hybrid system using both a TMD and a MR damper.result obtained Base shear increases with the increase in no of stories and there is decrease in base shear for mass ratio $M_d$ / M = 0.25. The TMD with mass ratio 0.25 is most effective in controlling the various parameters in a building when compared with mass ratio 0.5 and 0.75 in the study.

**Said Elias, Vasant Matsagar[7]** Wind response control of tall buildings installed with a tuned mass damper (TMD) is investigated. The performance of a TMD installed at the topmost floor of a 76-storey benchmark building is compared with the TMD installed at different floors (locations) of the building. Result obtained the installation of a TMD is effective in improving the dynamic performance of the building under the wind excitations. The peak and RMS acceleration response are reduced up to about 50%.The maximum peak and RMS displacement response reduction in case of the $TMD_1$ installed at the topmost floor and $TMD_2$, $TMD_3$, $TMD_4$, and $TMD_5$, respectively, are 30%, 25%, 15%, 8%, and 4%.

**Said Elias, Vasant Matsagar[8]** Distributed multiple tuned mass dampers (d-MTMDs) are installed for multimode control of the chimney including soil-structure interaction (SSI) subjected to along-wind forces is investigated. Comparison of peak responses is made for the chimney installed with the single tuned mass damper (STMD), distributed multiple tuned mass dampers all controlling the fundamental modal responses (d-MTMDs-1), arbitrarily distributed tuned mass dampers (ad-MTMDs), and distributed tuned mass dampers (d-MTMDs) subjected to along-wind forces with different mean wind velocity. Result obtained The d-MTMDs are more effective than the STMD, d-MTMDs-1, and adMTMDs, while considering equal total mass of the TMD(s).The responses of tall cylindrical chimneys drastically reduce under along-wind forces by increasing the foundation flexibility.

## III. PROBLEM STATEMENT

The example consists of designing a 27 storey moment resisting RC frame using Etabs. The frame has equal bay width of 5.0m and storey heights of 4.0m. It is located in Zone-IV and Zone-V. The building is assumed to be constructed in hard soil condition.

***Table 1. Structure Data***

| **Structure data** | |
|---|---|
| Beam | 250 x 600 mm |
| Story 1 to 9 | 500 x 1000 mm |
| Story 10 to 18 | 500 x 900 mm |
| Story 19 to 27 | 500 x 800 mm |
| Height of each story | 4 mm |
| Thickness of slab | 150 mm |
| Outer wall | 230 mm |
| Internal wall | 150 mm |
| Terrace wall | 150 mm |

| | |
|---|---|
| Grade of concrete | M 25 |
| Density of concrete | 25 KN / $m^2$ |
| Grade of steel | HYSD 415 |
| **Loading data** | |
| Live load | 3 kN /$m^2$ at all floor |
| Floor finish load | 1 kN /$m^2$ at all floor |
| Water Proofing | 2 kN /$m^2$ at Terrace |
| **Earthquake Data** | |
| Zone | IV OR V |
| Response reduction factor | R =5 As Par IS:1893-2002 , Page -23 |
| Importance factor | I = 1.5 As Per IS : 1893-2002, P-18 |
| Zone factor | 0.36 For Zone V |
| | 0.24 For Zone VI |
| Type of the site | I |

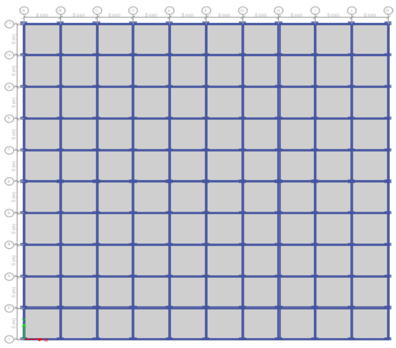

***Figure 1. Storey 1 to 9 Story plan***

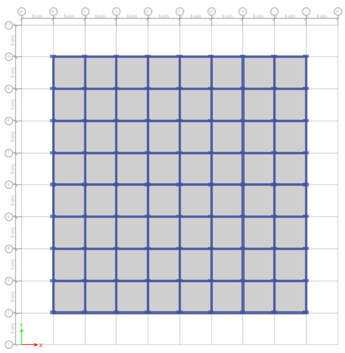

***Figure 2. Storey 10 to 18 Story plan***

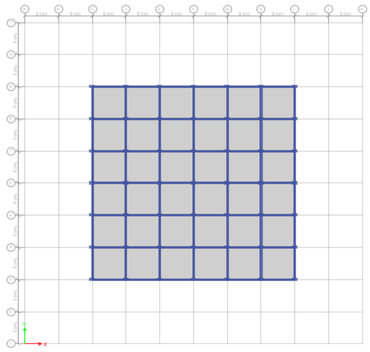

***Figure 3. Storey 19 to 27 Story plan***

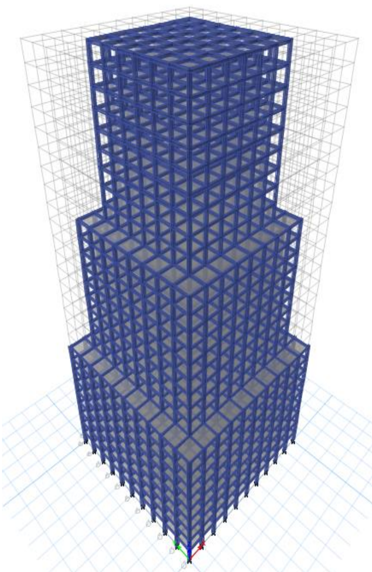

***Figure 4. 3-D model of structure***

In this study, as per given definition of scale factor for RSA in ETABS manual,

**SF= (I x g / 2R)**

For this study here,

**Importance factor I = 1.5**

**Response reduction factor R = 5**

**And gravitational acceleration g = 9.81.**
**So,**

For this value of scale factor in this study, Dynamic analysis base shear is less than Static analysis base shear. So according to clause 7.8.2 of IS 1893-2002.

**SF = (I x g / 2R) x 0.8 x (EQ-X Base Shear / RS-X Base Shear)**

In present study, following model are compared to each other in to different zone and comparison result are discuses in below

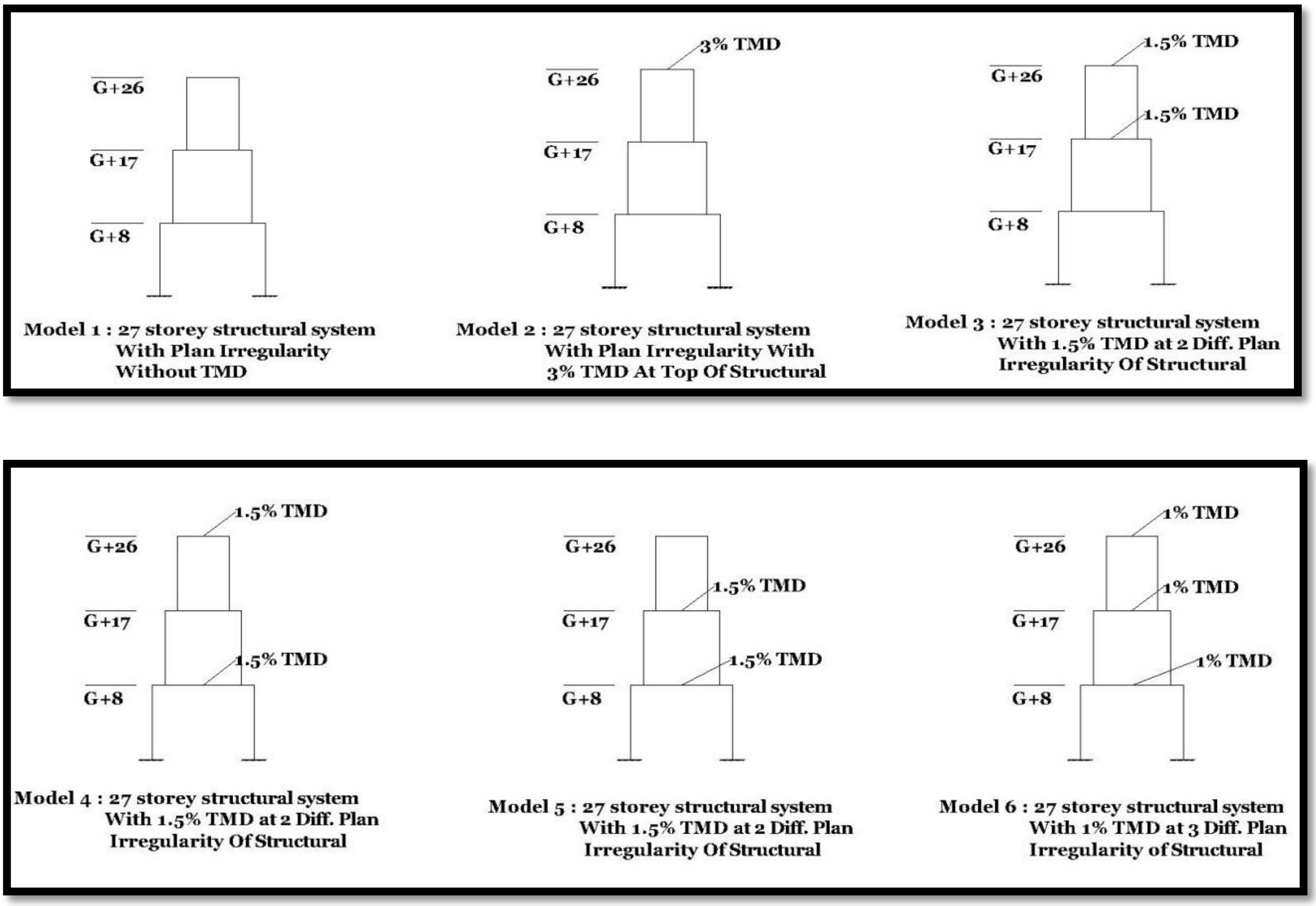


***Figure 5. Models***

***Table 2. TMD Details***

| | |
|---|---|
| **Total Mass Of Structure** | 729880.3 KN |
| **3 % TMD MASS** | 21896.409 KN |
| **1.5 % TMD MASS** | 10948.2045 KN |
| **1% TMD MASS** | 7298.803 KN |

## IV. RESULT AND DISCUSSION

The comparative results and graph for time period of All Models is shown in below.

***Table 3. Results for time period of All Models***

| Mode | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| **1** | 3.023 | 3.023 | 3.023 | 3.023 | 3.023 | 3.023 |
| **2** | 2.671 | 2.479 | 2.382 | 2.458 | 2.534 | 2.363 |
| **3** | 2.172 | 2.172 | 2.172 | 2.172 | 2.172 | 2.172 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **4** | 1.306 | 1.306 | 1.306 | 1.306 | 1.306 | 1.306 |
| **5** | 1.148 | 1.123 | 1.123 | 1.117 | 1.14 | 1.116 |
| **6** | 1.113 | 1.113 | 1.113 | 1.113 | 1.113 | 1.113 |
| **7** | 0.821 | 0.821 | 0.821 | 0.821 | 0.821 | 0.821 |
| **8** | 0.744 | 0.744 | 0.744 | 0.744 | 0.744 | 0.744 |
| **9** | 0.71 | 0.706 | 0.703 | 0.705 | 0.706 | 0.702 |
| **10** | 0.522 | 0.522 | 0.522 | 0.522 | 0.522 | 0.522 |
| **11** | 0.446 | 0.445 | 0.445 | 0.445 | 0.446 | 0.445 |
| **12** | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |

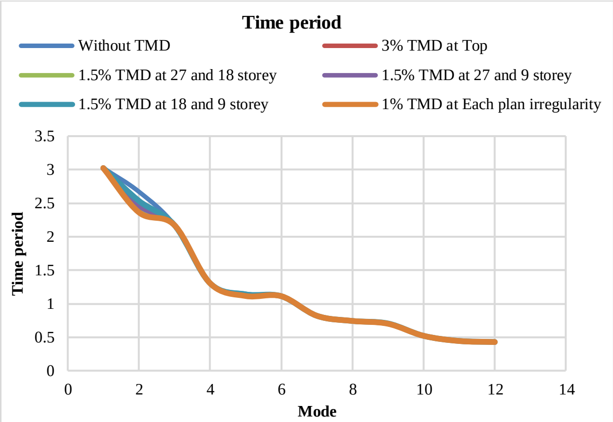


***Figure 6. Comparative Time Period of All Models***

The comparative results and graph for storey displacement of All Models for RSA X load in Zone V

***Table 4. Results for displacement due to RSA X load of All Models in Zone V***

| Story | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| **27** | 56.132 | 27.235 | 22.207 | 25.449 | 34.554 | 21.681 |
| **26** | 55.387 | 27.189 | 22.155 | 25.42 | 34.026 | 21.651 |
| **25** | 54.329 | 27.052 | 22.024 | 25.313 | 33.279 | 21.552 |
| **24** | 52.943 | 26.775 | 21.775 | 25.083 | 32.311 | 21.346 |
| **23** | 51.266 | 26.364 | 21.414 | 24.734 | 31.157 | 21.036 |
| **22** | 49.339 | 25.831 | 20.954 | 24.274 | 29.854 | 20.628 |
| **21** | 47.208 | 25.187 | 20.403 | 23.708 | 28.439 | 20.126 |
| **20** | 44.922 | 24.441 | 19.773 | 23.042 | 26.952 | 19.539 |
| **19** | 42.566 | 23.614 | 19.091 | 22.293 | 25.464 | 18.889 |
| **18** | 40.359 | 22.772 | 18.437 | 21.519 | 24.139 | 18.253 |
| **17** | 38.531 | 21.993 | 17.908 | 20.794 | 23.154 | 17.733 |
| **16** | 36.58 | 21.115 | 17.331 | 19.972 | 22.14 | 17.16 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **15** | 34.476 | 20.125 | 16.675 | 19.043 | 21.055 | 16.505 |
| **14** | 32.217 | 19.028 | 15.933 | 18.009 | 19.883 | 15.759 |
| **13** | 29.814 | 17.829 | 15.101 | 16.877 | 18.622 | 14.922 |
| **12** | 27.287 | 16.543 | 14.186 | 15.659 | 17.274 | 13.999 |
| **11** | 24.673 | 15.193 | 13.202 | 14.38 | 15.855 | 13.003 |
| **10** | 22.055 | 13.824 | 12.178 | 13.083 | 14.412 | 11.97 |
| **9** | 19.63 | 12.532 | 11.178 | 11.867 | 13.049 | 10.97 |
| **8** | 17.582 | 11.39 | 10.251 | 10.812 | 11.864 | 10.067 |
| **7** | 15.46 | 10.163 | 9.219 | 9.677 | 10.593 | 9.067 |
| **6** | 13.216 | 8.81 | 8.047 | 8.416 | 9.189 | 7.927 |
| **5** | 10.835 | 7.316 | 6.722 | 7.01 | 7.635 | 6.632 |
| **4** | 8.333 | 5.69 | 5.252 | 5.466 | 5.94 | 5.189 |
| **3** | 5.761 | 3.969 | 3.677 | 3.82 | 4.145 | 3.636 |
| **2** | 3.243 | 2.25 | 2.09 | 2.169 | 2.35 | 2.068 |
| **1** | 1.078 | 0.751 | 0.699 | 0.725 | 0.785 | 0.692 |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 |

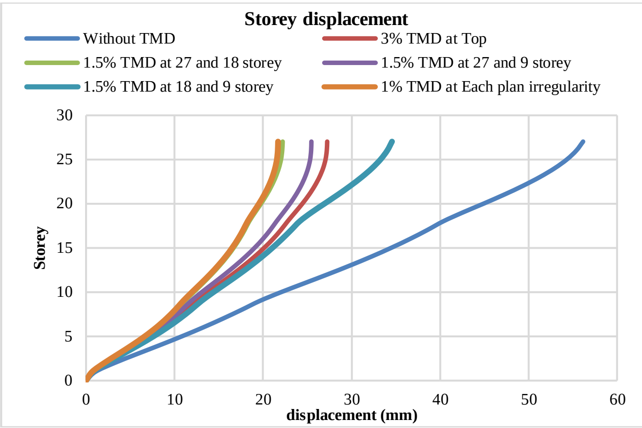


*Figure 7. Comparative of displacement of in Zone V*

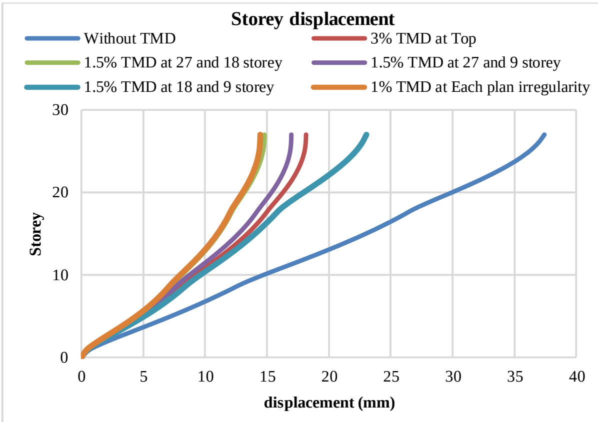


*Figure 8. Comparative of displacement of in Zone IV*

*Table 5. Results for displacement due to RSA X load of All Models in Zone IV*

| Story | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| 27 | 37.421 | 18.157 | 14.804 | 16.966 | 23.036 | 14.454 |
| 26 | 36.925 | 18.126 | 14.77 | 16.947 | 22.684 | 14.434 |
| 25 | 36.219 | 18.035 | 14.683 | 16.875 | 22.186 | 14.368 |
| 24 | 35.296 | 17.85 | 14.517 | 16.722 | 21.541 | 14.231 |
| 23 | 34.177 | 17.576 | 14.276 | 16.489 | 20.771 | 14.024 |
| 22 | 32.893 | 17.221 | 13.969 | 16.182 | 19.903 | 13.752 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | 31.472 | 16.791 | 13.602 | 15.805 | 18.959 | 13.417 |
| 20 | 29.948 | 16.294 | 13.182 | 15.362 | 17.968 | 13.026 |
| 19 | 28.377 | 15.743 | 12.728 | 14.862 | 16.976 | 12.593 |
| 18 | 26.906 | 15.181 | 12.291 | 14.346 | 16.093 | 12.168 |
| 17 | 25.687 | 14.662 | 11.939 | 13.863 | 15.436 | 11.822 |
| 16 | 24.387 | 14.076 | 11.554 | 13.315 | 14.76 | 11.44 |
| 15 | 22.984 | 13.417 | 11.117 | 12.695 | 14.036 | 11.003 |
| 14 | 21.478 | 12.685 | 10.622 | 12.006 | 13.255 | 10.506 |
| 13 | 19.876 | 11.886 | 10.068 | 11.251 | 12.415 | 9.948 |
| 12 | 18.191 | 11.029 | 9.458 | 10.44 | 11.516 | 9.332 |
| 11 | 16.449 | 10.129 | 8.801 | 9.586 | 10.57 | 8.669 |
| 10 | 14.703 | 9.216 | 8.119 | 8.722 | 9.608 | 7.98 |
| 9 | 13.087 | 8.354 | 7.452 | 7.911 | 8.7 | 7.313 |
| 8 | 11.722 | 7.594 | 6.834 | 7.208 | 7.91 | 6.711 |
| 7 | 10.307 | 6.775 | 6.146 | 6.451 | 7.062 | 6.045 |
| 6 | 8.81 | 5.873 | 5.365 | 5.61 | 6.126 | 5.285 |
| 5 | 7.223 | 4.878 | 4.481 | 4.673 | 5.09 | 4.421 |
| 4 | 5.555 | 3.793 | 3.502 | 3.644 | 3.96 | 3.459 |
| 3 | 3.84 | 2.646 | 2.451 | 2.547 | 2.763 | 2.424 |
| 2 | 2.162 | 1.5 | 1.393 | 1.446 | 1.566 | 1.379 |
| 1 | 0.719 | 0.501 | 0.466 | 0.483 | 0.523 | 0.461 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

***Table 6. Results for Storey drift due to RSA X load of All Models in Zone V***

| Story | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| **27** | 0.000262 | 0.00012 | 0.000106 | 0.000113 | 0.000197 | 0.0001 |
| **26** | 0.000387 | 0.000184 | 0.000163 | 0.000172 | 0.000291 | 0.000152 |
| **25** | 0.000512 | 0.000246 | 0.000217 | 0.000229 | 0.000383 | 0.000202 |
| **24** | 0.000617 | 0.000294 | 0.000259 | 0.00027 | 0.000457 | 0.000237 |
| **23** | 0.000699 | 0.000326 | 0.000286 | 0.000296 | 0.000512 | 0.00026 |
| **22** | 0.000761 | 0.000347 | 0.000305 | 0.000312 | 0.000551 | 0.000276 |
| **21** | 0.000805 | 0.000363 | 0.000322 | 0.000326 | 0.000579 | 0.000291 |
| **20** | 0.000819 | 0.000372 | 0.000333 | 0.000335 | 0.000587 | 0.000303 |
| **19** | 0.000748 | 0.000347 | 0.00031 | 0.000317 | 0.000529 | 0.000287 |
| **18** | 0.000583 | 0.000286 | 0.000243 | 0.000266 | 0.000393 | 0.000229 |
| **17** | 0.000607 | 0.00031 | 0.000256 | 0.000291 | 0.000398 | 0.000245 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **16** | 0.000639 | 0.000338 | 0.000274 | 0.000319 | 0.000411 | 0.000265 |
| **15** | 0.000672 | 0.000365 | 0.000292 | 0.000346 | 0.000424 | 0.000284 |
| **14** | 0.000702 | 0.00039 | 0.000311 | 0.000371 | 0.000437 | 0.000305 |
| **13** | 0.00073 | 0.000415 | 0.000332 | 0.000396 | 0.000452 | 0.000327 |
| **12** | 0.000751 | 0.000435 | 0.000351 | 0.000417 | 0.000467 | 0.000349 |
| **11** | 0.00075 | 0.000442 | 0.000361 | 0.000424 | 0.00047 | 0.000359 |
| **10** | 0.000686 | 0.000409 | 0.000338 | 0.000391 | 0.000432 | 0.000336 |
| **9** | 0.00056 | 0.000337 | 0.000284 | 0.000318 | 0.000352 | 0.000278 |
| **8** | 0.000565 | 0.000344 | 0.000295 | 0.000323 | 0.000358 | 0.000287 |
| **7** | 0.000583 | 0.000362 | 0.000316 | 0.000339 | 0.000376 | 0.000308 |
| **6** | 0.000607 | 0.000386 | 0.000343 | 0.000364 | 0.000402 | 0.000336 |
| **5** | 0.000631 | 0.000412 | 0.000372 | 0.000391 | 0.00043 | 0.000366 |
| **4** | 0.000645 | 0.000432 | 0.000395 | 0.000413 | 0.000451 | 0.00039 |
| **3** | 0.00063 | 0.00043 | 0.000397 | 0.000413 | 0.000449 | 0.000392 |
| **2** | 0.000541 | 0.000375 | 0.000348 | 0.000361 | 0.000391 | 0.000344 |
| **1** | 0.000269 | 0.000188 | 0.000175 | 0.000181 | 0.000196 | 0.000173 |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 |

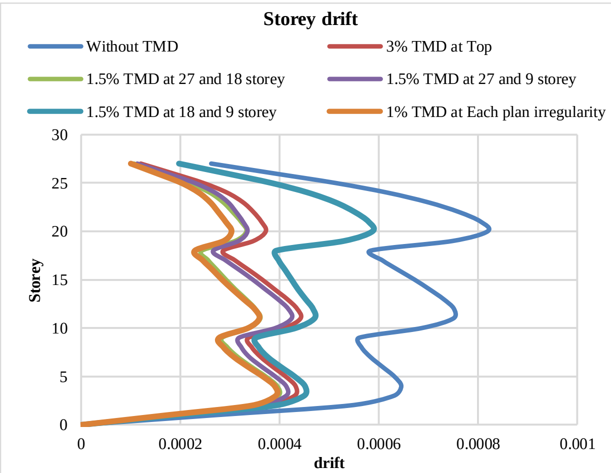


*Figure 9. Comparative of Storey drift of in Zone V*

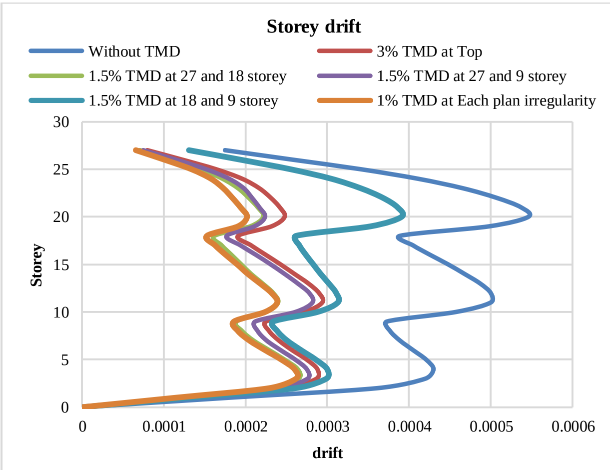


*Figure 10. Comparative of Storey drift of in Zone IV*

*Table 7. Results for Storey drift due to RSA X load of All Models in Zone IV*

| Story | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| 27 | 0.000175 | 0.00008 | 0.000071 | 0.000075 | 0.000131 | 0.000066 |
| 26 | 0.000258 | 0.000123 | 0.000109 | 0.000115 | 0.000194 | 0.000101 |
| 25 | 0.000341 | 0.000164 | 0.000145 | 0.000152 | 0.000255 | 0.000134 |
| 24 | 0.000411 | 0.000196 | 0.000172 | 0.00018 | 0.000305 | 0.000158 |
| 23 | 0.000466 | 0.000217 | 0.000191 | 0.000198 | 0.000341 | 0.000173 |
| 22 | 0.000507 | 0.000231 | 0.000204 | 0.000208 | 0.000368 | 0.000184 |
| 21 | 0.000537 | 0.000242 | 0.000215 | 0.000217 | 0.000386 | 0.000194 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 | 0.000546 | 0.000248 | 0.000222 | 0.000224 | 0.000391 | 0.000202 |
| 19 | 0.000498 | 0.000232 | 0.000206 | 0.000211 | 0.000353 | 0.000191 |
| 18 | 0.000389 | 0.000191 | 0.000162 | 0.000177 | 0.000262 | 0.000153 |
| 17 | 0.000405 | 0.000207 | 0.000171 | 0.000194 | 0.000266 | 0.000163 |
| 16 | 0.000426 | 0.000225 | 0.000183 | 0.000213 | 0.000274 | 0.000176 |
| 15 | 0.000448 | 0.000243 | 0.000195 | 0.000231 | 0.000283 | 0.00019 |
| 14 | 0.000468 | 0.00026 | 0.000207 | 0.000248 | 0.000292 | 0.000203 |
| 13 | 0.000487 | 0.000277 | 0.000221 | 0.000264 | 0.000302 | 0.000218 |
| 12 | 0.0005 | 0.00029 | 0.000234 | 0.000278 | 0.000311 | 0.000232 |
| 11 | 0.0005 | 0.000294 | 0.00024 | 0.000282 | 0.000313 | 0.000239 |
| 10 | 0.000457 | 0.000272 | 0.000225 | 0.000261 | 0.000288 | 0.000224 |
| 9 | 0.000373 | 0.000225 | 0.000189 | 0.000212 | 0.000234 | 0.000186 |
| 8 | 0.000377 | 0.000229 | 0.000196 | 0.000215 | 0.000239 | 0.000191 |
| 7 | 0.000389 | 0.000241 | 0.00021 | 0.000226 | 0.000251 | 0.000205 |
| 6 | 0.000405 | 0.000257 | 0.000229 | 0.000243 | 0.000268 | 0.000224 |
| 5 | 0.000421 | 0.000275 | 0.000248 | 0.000261 | 0.000286 | 0.000244 |
| 4 | 0.00043 | 0.000288 | 0.000264 | 0.000275 | 0.0003 | 0.00026 |
| 3 | 0.00042 | 0.000287 | 0.000265 | 0.000276 | 0.000299 | 0.000262 |
| 2 | 0.000361 | 0.00025 | 0.000232 | 0.000241 | 0.000261 | 0.000229 |
| 1 | 0.00018 | 0.000125 | 0.000116 | 0.000121 | 0.000131 | 0.000115 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

***Table 8. Results for Storey Shear due to RSA X load of All Models in Zone V***

| Story | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| 27 | 405.3699 | 250.93 | 216.1086 | 240.6232 | 316.2478 | 211.0919 |
| 26 | 832.7764 | 435.626 | 386.0026 | 413.3618 | 643.3987 | 366.9059 |
| 25 | 1193.7059 | 613.313 | 541.747 | 574.718 | 910.0055 | 507.7246 |
| 24 | 1479.4046 | 739.836 | 649.6935 | 684.2386 | 1109.4368 | 600.742 |
| 23 | 1696.6788 | 817.241 | 715.2256 | 745.2554 | 1251.0356 | 652.1806 |
| 22 | 1864.6954 | 867.247 | 761.4945 | 781.628 | 1356.7517 | 687.493 |
| 21 | 2005.5628 | 917.532 | 815.00 | 823.9213 | 1450.146 | 736.1519 |
| 20 | 2133.6007 | 984.496 | 887.4127 | 889.636 | 1543.2779 | 810.4183 |
| 19 | 2251.1104 | 1064.68 | 969.5565 | 973.0895 | 1632.2203 | 898.5396 |
| 18 | 2440.3723 | 1213.66 | 1021.1926 | 1128.7347 | 1636.1961 | 958.8583 |
| 17 | 2647.9184 | 1380.67 | 1147.1964 | 1299.1542 | 1757.534 | 1095.3388 |
| 16 | 2837.8761 | 1529.09 | 1249.1455 | 1447.5356 | 1849.4455 | 1205.6998 |
| 15 | 3006.605 | 1658.75 | 1334.2483 | 1575.6422 | 1916.6259 | 1298.6493 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 14 | 3165.5515 | 1784.72 | 1425.2829 | 1700.3341 | 1983.5992 | 1397.7891 |
| 13 | 3326.9908 | 1919.08 | 1539.0728 | 1834.6929 | 2074.3536 | 1519.7515 |
| 12 | 3491.4854 | 2058.28 | 1670.8733 | 1975.0782 | 2192.3648 | 1659.1978 |
| 11 | 3646.3278 | 2184.97 | 1798.3469 | 2103.5158 | 2318.2713 | 1793.6401 |
| 10 | 3776.0836 | 2282.13 | 1900.0323 | 2202.5567 | 2427.113 | 1902.025 |
| 9 | 3938.6753 | 2393.14 | 2021.463 | 2230.4507 | 2467.162 | 1955.9093 |
| 8 | 4115.7936 | 2520.83 | 2165.0488 | 2352.843 | 2613.2718 | 2099.1435 |
| 7 | 4311.4398 | 2682.86 | 2347.6258 | 2514.9675 | 2792.0921 | 2284.7098 |
| 6 | 4536.5933 | 2894.43 | 2582.1428 | 2732.469 | 3018.1317 | 2525.352 |
| 5 | 4786.5633 | 3146.59 | 2855.7775 | 2994.2973 | 3283.7681 | 2806.5423 |
| 4 | 5035.4369 | 3404.7 | 3130.7171 | 3262.5831 | 3554.7837 | 3088.5344 |
| 3 | 5244.0304 | 3622.4 | 3359.5527 | 3488.4637 | 3783.5289 | 3322.6811 |
| 2 | 5377.2162 | 3761.35 | 3504.4402 | 3632.3663 | 3929.7081 | 3470.6762 |
| 1 | 5424.5579 | 3810.74 | 3555.7578 | 3683.4711 | 3981.698 | 3523.0527 |

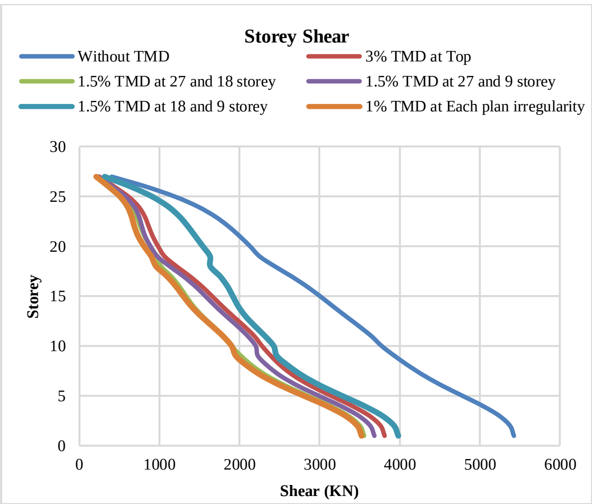


*Figure 11. Comparative of Storey Shear of in Zone V*

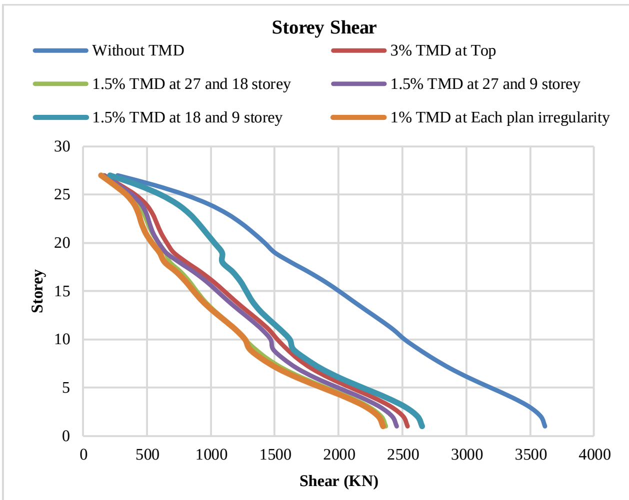


*Figure 12. Comparative of Storey Shear of in Zone IV*

*Table 9. Results for Storey Shear due to RSA X load of All Models in Zone V*

| Story | Without TMD | 3% TMD at Top | 1.5% TMD at 27 and 18 storey | 1.5% TMD at 27 and 9 storey | 1.5% TMD at 18 and 9 storey | 1% TMD at Each plan irregularity |
|---|---|---|---|---|---|---|
| 27 | 270.2466 | 167.2867 | 144.0724 | 160.4155 | 210.832 | 140.728 |
| 26 | 555.1843 | 290.4172 | 257.335 | 275.5745 | 428.932 | 244.6039 |
| 25 | 795.804 | 408.8751 | 361.1647 | 383.1453 | 606.67 | 338.4831 |
| 24 | 986.2698 | 493.224 | 433.129 | 456.1591 | 739.625 | 400.4947 |
| 23 | 1131.119 | 544.8275 | 476.8171 | 496.8369 | 834.024 | 434.7871 |
| 22 | 1243.13 | 578.1645 | 507.663 | 521.0853 | 904.501 | 458.3287 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | 1337.042 | 611.6882 | 543.3334 | 549.2809 | 966.764 | 490.7679 |
| 20 | 1422.4 | 656.3309 | 591.6085 | 593.0907 | 1028.85 | 540.2789 |
| 19 | 1500.74 | 709.7846 | 646.371 | 648.7264 | 1088.15 | 599.0264 |
| 18 | 1626.915 | 809.1067 | 680.7951 | 752.4898 | 1090.8 | 639.2389 |
| 17 | 1765.279 | 920.4481 | 764.7976 | 866.1028 | 1171.69 | 730.2259 |
| 16 | 1891.917 | 1019.391 | 832.7636 | 965.0237 | 1232.96 | 803.7999 |
| 15 | 2004.403 | 1105.836 | 889.4989 | 1050.4282 | 1277.75 | 865.7662 |
| 14 | 2110.368 | 1189.812 | 950.1886 | 1133.5561 | 1322.4 | 931.8594 |
| 13 | 2217.994 | 1279.386 | 1026.0485 | 1223.1286 | 1382.9 | 1013.168 |
| 12 | 2327.657 | 1372.188 | 1113.9155 | 1316.7188 | 1461.58 | 1106.132 |
| 11 | 2430.885 | 1456.647 | 1198.8979 | 1402.3439 | 1545.51 | 1195.76 |
| 10 | 2517.389 | 1521.419 | 1266.6882 | 1468.3711 | 1618.08 | 1268.017 |
| 9 | 2625.784 | 1595.429 | 1347.642 | 1486.9671 | 1644.77 | 1303.94 |
| 8 | 2743.862 | 1680.553 | 1443.3659 | 1568.562 | 1742.18 | 1399.429 |
| 7 | 2874.293 | 1788.574 | 1565.0839 | 1676.645 | 1861.39 | 1523.14 |
| 6 | 3024.396 | 1929.619 | 1721.4285 | 1821.646 | 2012.09 | 1683.568 |
| 5 | 3191.042 | 2097.73 | 1903.8517 | 1996.1982 | 2189.18 | 1871.028 |
| 4 | 3356.958 | 2269.801 | 2087.1447 | 2175.0554 | 2369.86 | 2059.023 |
| 3 | 3496.02 | 2414.936 | 2239.7018 | 2325.6424 | 2522.35 | 2215.121 |
| 2 | 3584.811 | 2507.566 | 2336.2935 | 2421.5775 | 2619.81 | 2313.784 |
| 1 | 3616.372 | 2540.491 | 2370.5052 | 2455.6474 | 2654.47 | 2348.702 |

## V. REMARKS

Analysis of G+26 storey RCC structure with and without TMD in Zone V and Zone IV is carried out by using response spectrum method. Time period is less, lesser is mass of structure and more is the stiffness of structure. From all model comparison graph it can be see that 1% TMD at each plan irregularity of structure is reduced 11.53% in time period compared without TMD structure, indicates that 1% TMD at each plan irregularity of structure has higher stiffness compared to structure without TMD. From all model comparison graph it seen that 1% TMD at each plan irregularity of structure is more effective compared to the other types of model, there is 61.37% reduction of story displacement of 1% TMD at each plan irregularity of structure to without TMD of structure. Also seen that structure without TMD gives highest displacement for all stories in both zone while incorporate TMD structure gives better result. From graph it can be seen that in Zone V All parameter of structure has higher than zone IV structure so as seismic zone level increase then all parameter are also increase. Out of all analysis it is observed that MTMD system is more effective in structure compare to STMD.

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