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# Determination of Appropriate Time Period to be used Analyzing Multiblock Tall Buildings

Mr. Sajeet S B
Structural Engineer
Bengaluru-560086, India

Mr. Janardhana K
Assistant Professor, Department of CivilEngineering PES University,Banashankari,
Bengaluru-560085, India,

Mr. Akshay K Uday
Post-graduate Student-M.Tech (StructuralEngineering),
PES University,Banashankari,
Bengaluru-560085, India,

***Abstract*— In present days, structures exceeding 45m in length are designed with one or more expansion joint, where the building are split into two or more and behaves independent. In this study as per the code IS 456-2000 or IS 3414(1968), the building is modeled with expansion joint over a podium in ETABS. Now, while entering the time period for static earthquake forces, in the multiblock tall buildings over podium, structural engineers face challenge to select the building from which the time period has to be selected. Structural engineers had different perspectives on choosing the appropriate time period. But, usual practice was to take the entire buildings plan ignoring the expansion joint. This study discusses how to determine an appropriate time period considering the expansion joint, which time period is to be used in analysing the multi-block tall buildings with an expansion joint over a podium. The time period obtained from the larger size plan should be considered for earthquake analysis of the building**

***Keywords—Horizontal dimensional, expansion joint, earthquake forces, time period***

## 1.1 INTRODUCTION

Atimeperiod(denotedby'T')isthetimerequired for one complete cycle of vibration to pass in a given point. As the frequency of a wave increases, the time period of the wave decreases. The unit for time period is 'seconds'. Frequencyand timeperiod are in a reciprocal relationship that can be expressed mathematically as: $T = 1/f$ or as: $f = 1/T$

An expansion joint or movement joint is an assembly designed to safely absorb the temperature-induced expansion and contraction of construction materials, to absorb vibration, to hold parts together, or to allow movement due to ground settlement or earthquakes.They are commonly found between sections of buildings, bridges, sidewalks, railway tracks, piping systems, ships, and otherstructures.

Building faces, concrete slabs, and pipelines expand and contract due to warming and cooling from seasonal variation, or due to other heat sources. Before expansion joint gaps were built into these structures, they would crack under the stress induced.

## 1.2 THE OBJECTIVES OF THIS STUDY CAN BELISTED AS FOLLOWS:

- TostudytheEarthquakeresponseofRCC Tall Building with variation of time period inX directionfordifferenttypesofplansbyresponsespectrum analysis.(Individual modelanalysis)
- TostudytheEarthquakeresponseofRCC Tall Building with variation of time period in y directionfordifferenttypesofplansbyresponse spectrum analysis. (Individual modelanalysis)
- TostudytheEarthquakeresponseofRCC Tall Building with variation of time period in x & y direction for different types of plans by response spectrum analysis. (Individual model analysis)
- To Identify the worst time period, when two different building are at samepodium.

## 1.3 PRESENT STUDY

In present days, the design industries face design failures. The structural engineers go through many possible works identifying the worsttimeperiodwhilemodelingtwodifferent model in a single plane. For instance, when we consider two buildings, where the height of the building remains same, but their plan size is different. Initially, considering two models in a single podium assuming anyone of the model's time period was the usual method. Since, considering two buildings we obtain fourinputs of time period. Whereas, ETABS has optionsof only two input. Hence, we sequentially analyse individual model and compare the earthquake response of both the models. We have to identify worst earthquake response among the two models. Once identified, the worst earthquake response of a model, that is given as the input time period from that model and has to be taken for furtheranalysis.

## 1.4 RESPONSE SPECTRUMANALYSIS

The procedure to compute the peak response of structureduringtheearthquakedirectlyfromthe earthquake response spectrum without the need of time history analysis iscalled response spectrum analysis. A typical design response spectrum(IS-1893) is shown below inFigure 1.

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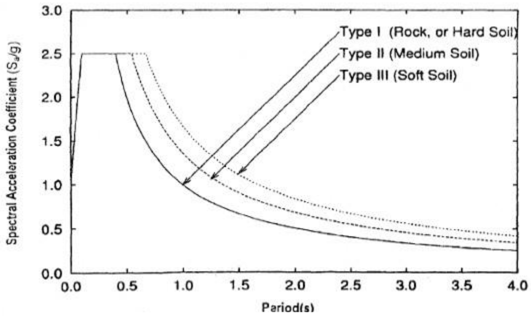
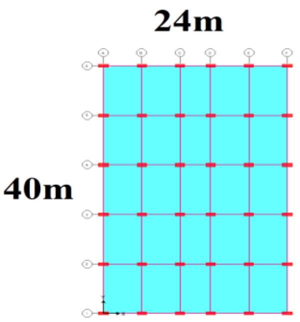


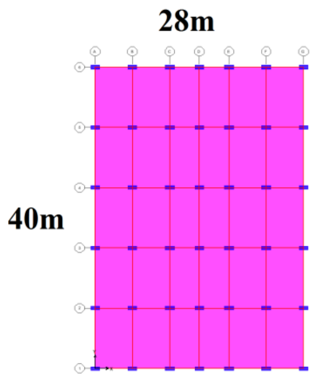

Fig 1: Design Response spectrum

MODEL 1



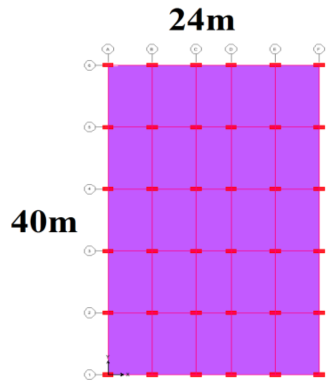

(PLAN SIZE)
X=24m
Y=40m
$T=\frac{0.09Xh}{\sqrt{d}}$ (sec)
as per IS 1893-2016 PART1
X=0.854
Y=0.661

MODEL 2



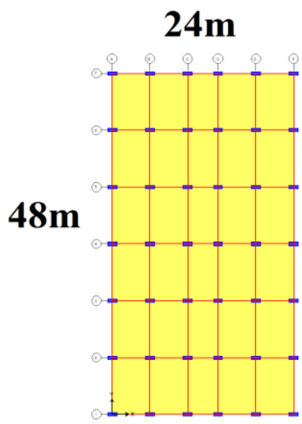

(PLAN SIZE)
X=28m
Y=40m
$T=\frac{0.09Xh}{\sqrt{d}}$ (sec)
as per IS 1893-2016 PART1
X=0.790
Y=0.661

MODEL 3




(PLAN SIZE)
X=24m
Y=40m
$T=\frac{0.09Xh}{\sqrt{d}}$ (sec)
as per IS 1893-2016 PART1
X=0.854
Y=0.661

MODEL 4




(PLAN SIZE)
X=24m
Y=48m
$T=\frac{0.09Xh}{\sqrt{d}}$ (sec)
as per IS 1893-2016 PART1
X=0.854
Y=0.604

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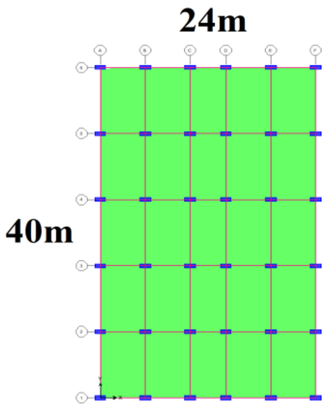
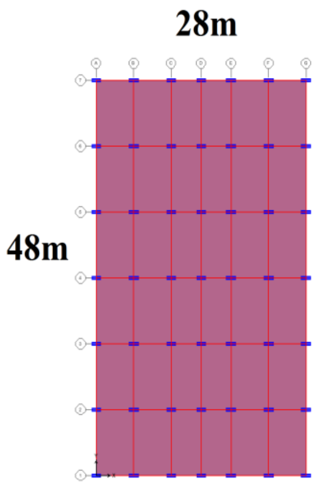
MODEL 5



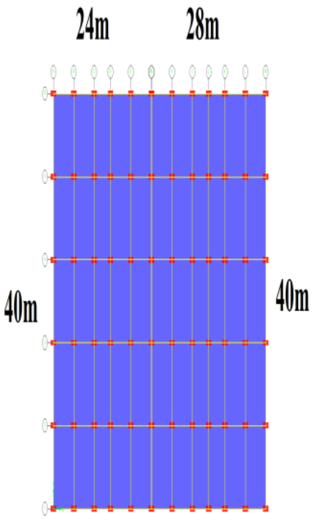

(PLAN SIZE)
X=24m
Y=40m
T= $\frac{0.09Xh}{\sqrt{d}}$ (sec)
as per IS 1893-2016 PART1
X=0.854
Y=0.661

MODEL 6



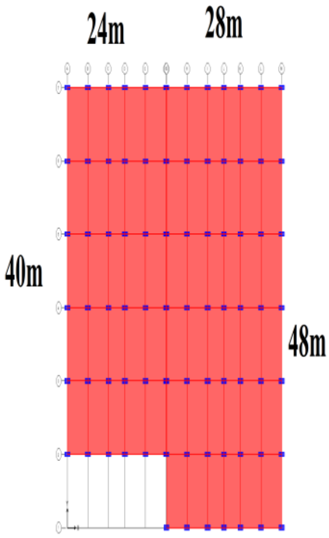

(PLAN SIZE)
X=28m
Y=48m
T= $\frac{0.09Xh}{\sqrt{d}}$ (sec)
as per IS 1893-2016 PART1
X=0.790
Y=0.604

MODEL 7




(24 x 40 m) and (28 x 40 m)
With 0.100m expansion joint

MODEL 8




(24 x 40 m) and (28 x 48 m)
With 0.100m expansion joint

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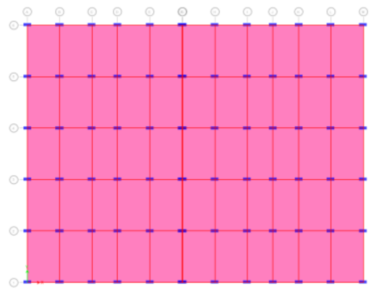
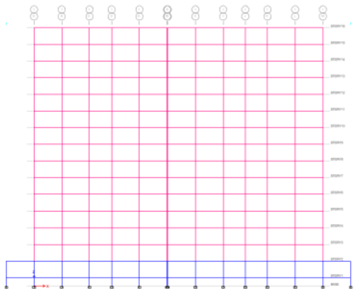
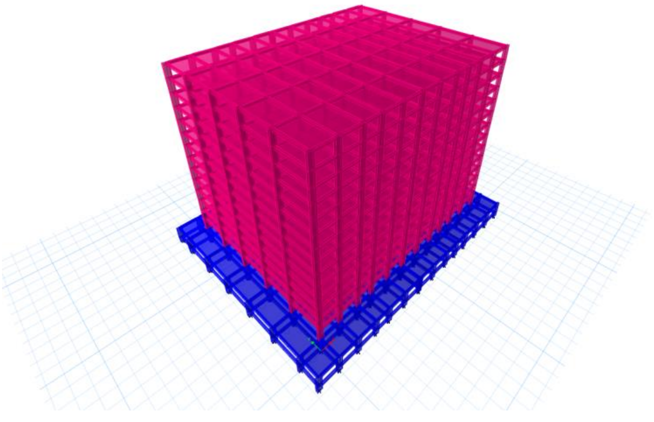
MODEL 7



building Plan view combined model 7

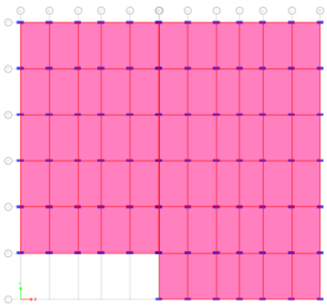


Building elevation view combined model 7

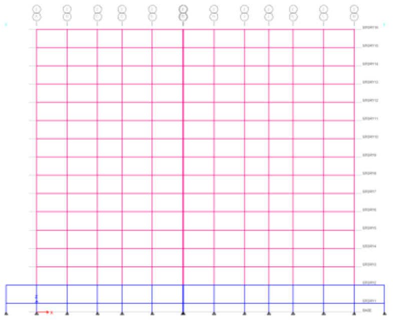


Building isometric view combined model 7

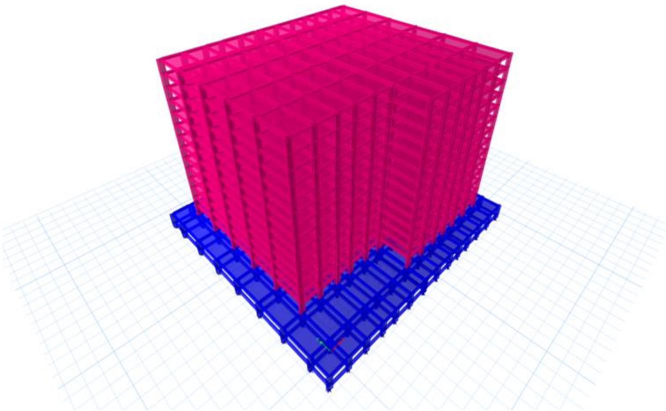
MODEL 8



Building plan view combined model 8



Building elevation view combined model 8



Building isometric view combined model 8

SEISMIC LOADING ZONE AS PER IS:1893-2016(PART 1)

| MODEL TYPE | ALL MODELS |
|---|---|
| R | 3 |
| I | 1 |
| Z | .10 |
| Sa/G | Type2 |

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MATERIAL PROPERTIES

| MODEL TYPE | ALL MODELS |
|---|---|
| MATERIAL PROPERTIES | |
| Column | M40 |
| Beam | M25 |
| Slab | M25 |

Density of concrete: 25 KN/m3
Density of brick masonry: 21.20 KN/m3
Slab thickness: 120 mm
Wall thickness: 230 mm

STATIC LOAD ASSIGNMENT

The loads considered are Dead Load, Live Load, Floor Finish, and Earth Quake Load. All models consist of these loads.
Dead Load: The dead load of the structure is obtained from Table 1, Page 8, of IS 875 – Part 1 – 1987. The permissible value for unit weight of reinforced concrete varies from 24.80kN/$m_3$ to 26.50 kN/$m_3$. From the table, the unit weight of concrete is taken as 25kN/$m_3$. The software has a inbuilt DL calculator
Self weight of the structural elements
Floor finish = 1.5 kN/$m_2$ and
Wall load on all beams is 11 kN/m
Imposed Load: The imposed load on the floor is obtained from Table 1 of IS 875 (Part 2) – 1987. The uniformly distributed load on the floor of the building is assumed to be 4.0 kN/$m_2$ (for assembly areas, corridors, passages, restaurants business and office buildings, retail shops etc).
On roof 1.5 kN/$m_2$, and
On floors 3.5 kN/m2
Earth Quake Load: The structure is assumed to be in Zone-II as per IS 1893 – 2016 (PART 1). So the zone factor is taken as per Table 2 of IS 1893 – 2002. The damping is assumed to be 5%, for concrete as per Table 3 of IS 1893-2016 (PART 1).. Importance factor is taken as 1 as per Table 6 of IS 1893 – 2016 (PART 1).
Zone II, Soil type II, Importance factor =1.2
Load combinations: The load combinations is obtained from page no13, clause 6.3.1.2 of. IS 1893 – 2016 (PART 1)..
DLEQX=1.2 (DL+LL+SPEC1)
DLEQY=1.2(DL+LL+SPEC2)

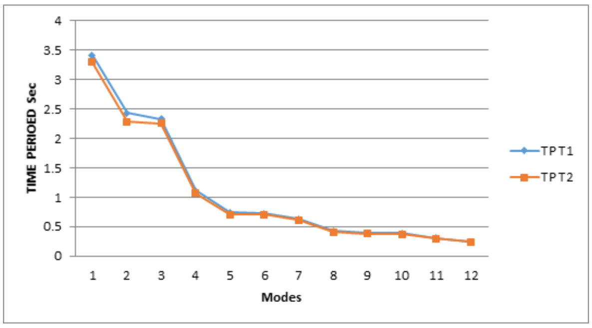
1.5 ANALYSIS INPUT

Table below shows input for response spectra analysis for various types of models ,

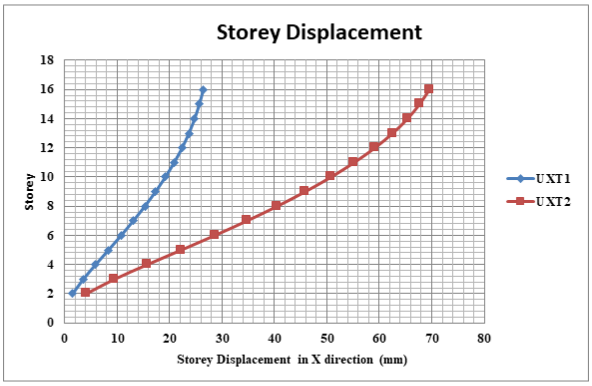
| TYPES | All models | All models |
|---|---|---|
| R VALUE | R=3 | R=3 |
| Function input | 0.1 | 0.1 |
| spectrum case name | Spec x | Spec y |
| structural and function damping | 0.05 | 0.05 |
| model combination | CQC | CQC |
| directional combination | SRSS | SRSS |
| input response spectra | 1.2x9.81/2 x3 | 1.2x9.81/2x 3 |
| eccentricity ratio | 0.05 | 0.05 |

1.6 RESULTS

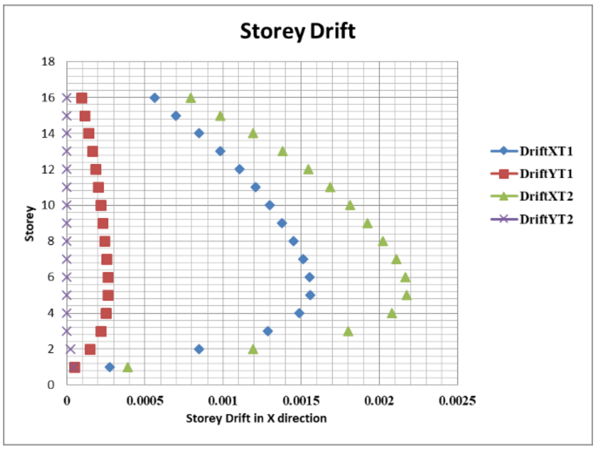
MODEL 1




TIME PERIOD OF MODEL 1




STOREY DISPLACEMENT OF MODEL 1




STOREY DRIFT OF MODEL 1

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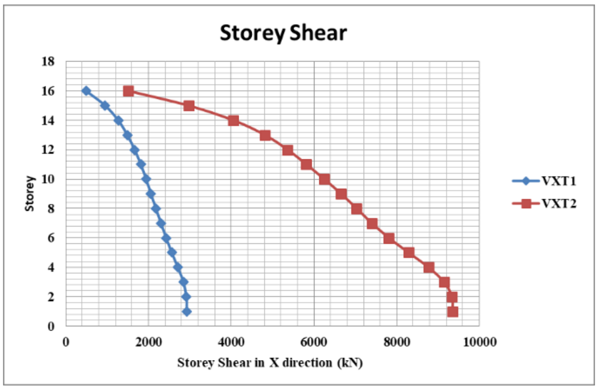
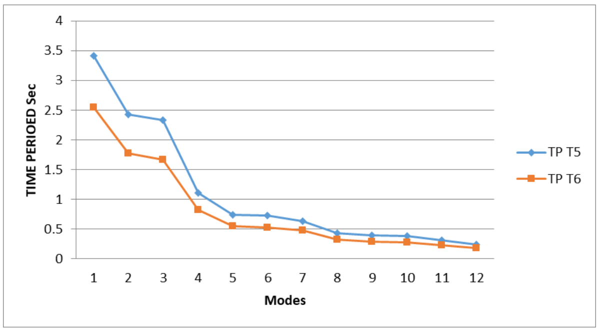


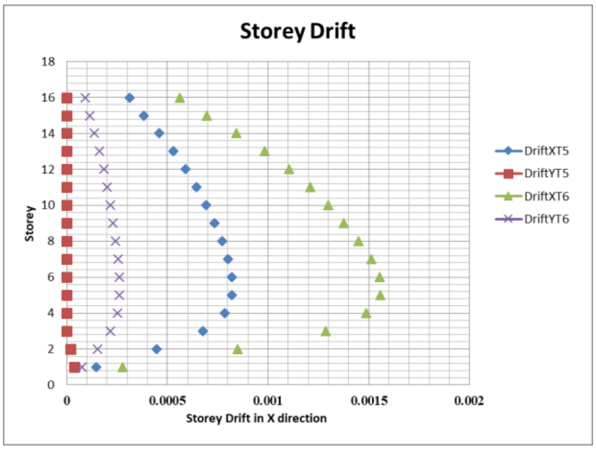

STOREY SHEAR OF MODEL 1

MODEL 3

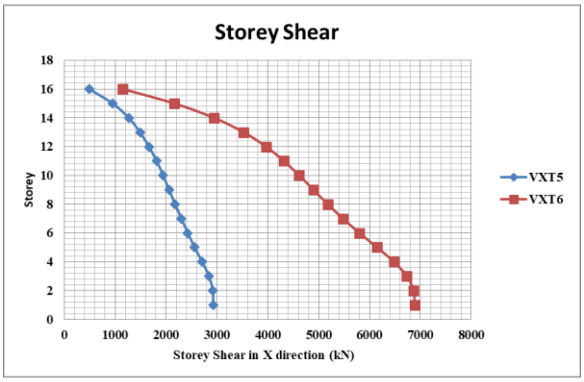



TIME PERIOD OF MODEL 3


STOREY DISPLACEMENT OF MODEL 3

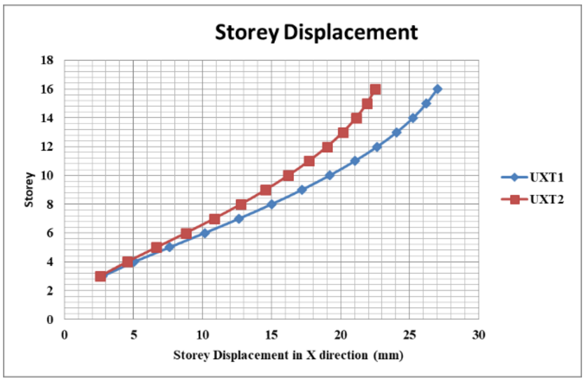



STOREY DRIFT OF MODEL 3

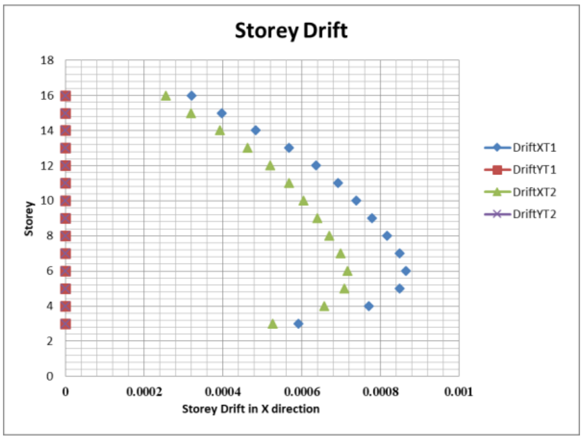



STOREY SHEAR OF MODEL 3

MODEL 7




STOREY DISPLACEMENT OF MODEL 7




STOREY DRIFT OF MODEL 7

MODEL 8


STOREY DISPLACEMENT OF MODEL 8

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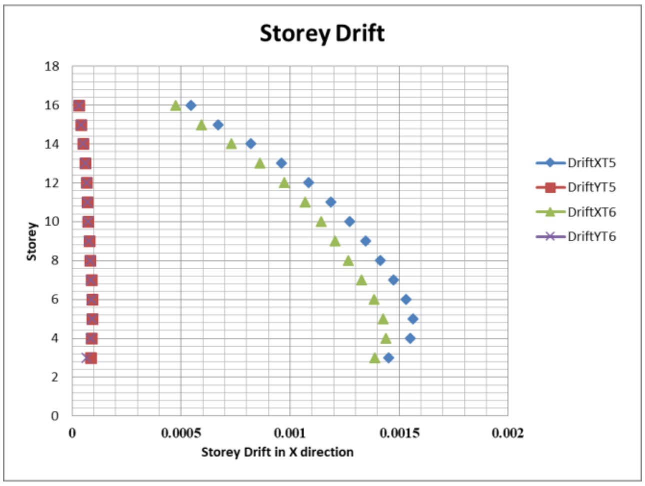


STOREY DIRIFT OF MODEL 8

*1.7 CONCLUSION*

Behaviour of earthquake in first phase shows that, as the dimensions of the building increases the time period will decrease but the modal time period increases. The earthquake response of the buildings like displacement, storey drift, and storey shear will increase.

In second phase it is observed that as the dimensions of the building increases the time period will decrease but the modal time period also decreases as the orientation of columns are in horizontal direction. The earthquake response of the buildings like displacement, storey drift, and storey shear will increase.

In third phase it is observed that as the dimensions of the building increases the time period will decrease but the modal time period increases. The earthquake response of the buildings like displacement, storey drift, and storey shear will increase.

Considering the first three phases, it is concluded that the time period of the building with larger horizontal dimension is considered as the appropriate time period for the combined models in fourth phase.

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