# STUDY ON TIME PERIOD AS PER IS CODE USING ETABS SOFTWARE

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**Abstract**
**In order to understand the performance of the building under seismic effect and the effect of lateral loads on a structure, it is necessary to evaluate the time period of a structure. It is necessary to determine the significance of the time period before evaluating the time period of a structure. Time period plays an important role in estimating the lateral loads and hence contributes to the seismic assessment of a structure. Time period depends on mass and stiffness. Based on the time period which is purely dependent on stiffness and mass, the behaviour of building under lateral loads can be evaluated. It is difficult to determine the exact time period. For the design of earthquake resistant structures which seem to be safe and economical, the determination of time period is necessary. In this paper an attempt is done to understand the various parameters which affect the time period of a building. Hence a parametric study is done on time period of a structure as per the codal provisions. IS code (IS 1893(part I):2016) is referred for the parametric study. The model is prepared and analysed using ETABS software considering various parameters in the model. The value obtained for time period as per the code and as per the software is compared. The variation in time period from model to model by varying the parameters is studied.**

**Keywords: Time period, orientation of columns, grade of concrete, slab thickness, ETABS.**

## I. INTRODUCTION

Time period formula as per IS codes relates overall height of the building and the base dimension of the building. Time period plays an important role in design of earthquake resistant structures. As per the codes such as United States (US) and Egyptian codes and as per the recommendations provided in many researches, the fundamental period of vibration is estimated by considering the overall height of the building or by the number of storeys. Both the factors are not considered together [2].

Many design codes are available for the design of earthquake resistant structures. Simple relationships are available in many codes which relate the height of the building with the fundamental time period. These relationships are for force based design which will estimate the time period and hence the base shear force can be predicted.

## II. SCOPE AND OBJECTIVES

•The objective of the parametric study is to determine the factors affecting the time period.
•Proper study of the code IS 1893:2002. Learning ETABS software and seismic analysis is done using the software.
•Studying the parameters affecting the time period.
•Performing manual and ETABS software analysis and comparing the results obtained.
•Using ETABS software finding the variation in the time period result considering various parameters.
•Varying the parameters such as grade of concrete, slab thickness, orientation of columns, each storey height, number of bays, loading, zones, soil type, beam ratios, column ratios etc and finding the changes in the time period results.
•Finding the main parameters which affect the time period of structure.

•The formula mentioned for time period in IS 1893:2002, is dependent only on overall height of the building.
•In the present study, research is carried out for determining the parameters affecting the time period.
•The present research is carried out on factors such as orientation of columns, grade of concrete, slab thickness, column dimensions.
•The future research or scope of work is carried out on factors such as dimensions of columns, beams, number of bays, number of storeys, different loading criteria etc.
•Research is done to show that not only height of building but also other parameters may affect the time period.

## III. METH0DOLOGY

For the study, a building model is created with all the necessary specifications such as beam dimension, column dimension, slab thickness, loadings etc. Building specifications taken are as follows.
G+6 building model is considered
Overall height of building = 21.45m
Beam dimension = 230x450mm
Column dimension = 230x450mm
Slab thickness = 130mm
Number of bays (X-axis) = 4 bays
Number of bays (Y-axis) = 4 bays
Spacing of each bay (X-axis) = 2.5m
Spacing of each bay (Y-axis) = 2.5m
Each storey height = 3m
Grade of concrete (beams & slabs) = M25
Grade of concrete (columns) = M30
Soil type = II
Zone = III
Grade of steel = fy500
The above building specifications are entered into the software and the model is analyzed. The parameters are varied from model to model and the variation in time period is noted down.

The loading details are taken as follows.
Dead load (slab load) = 1kN/m²
Live load (roof slab) = 1.5kN/m², on other slabs = 2.5kN/m²
Masonry load on beams = 13kN/m, on roof beams = 4kN/m

The earthquake loading is done as per mentioned in IS 1893(Part 1):2016-*"Criteria for Earthquake Resistant Design of Structures"*, part 1 general provisions and buildings, Bureau of Indian Standards, New Delhi, 2016.
Zone considered is zone III
Z = 0.16
I = 1

The fundamental natural period (Ta) of the buildings is determined using the formula mentioned below.
$\mathbf{Ta = 0.075}h^{\mathbf{0.75}}$ for a moment resisting RC frame building without brick infill wall
Where,
h – Height of building in m
Ta – time period of structure in sec

$\mathbf{Ta = \frac{0.09h}{\sqrt{d}}}$ for a moment resisting RC frame building with brick infill wall
Where,
d – base dimension of the building at the plinth level along the considered direction of earthquake shaking in m
Based on the above formula the time period is evaluated in ETABS software.

The plan view of the model is as shown in figure. The plan view gives a clear idea of the placing of columns, orientation of columns, number of bays in X-axis, number of bays in Y-axis. The spacing of each bay is clearly shown in the figure. The plan view clearly shows the 4 number of bays in X direction and 4 number of bays in Y direction.

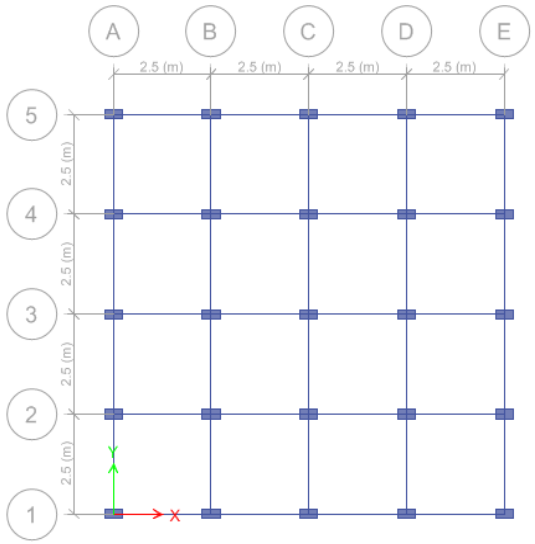


**Fig 1 Plan view of project model**

The 3-D view of the project model in a extruded view manner is shown in the below figure. The 3-D view of the model gives a clear idea of the

elevation of the building. It shows the appearance of the building model in all the 3 directions (3 axis namely X- axis, Y-axis, Z-axis).

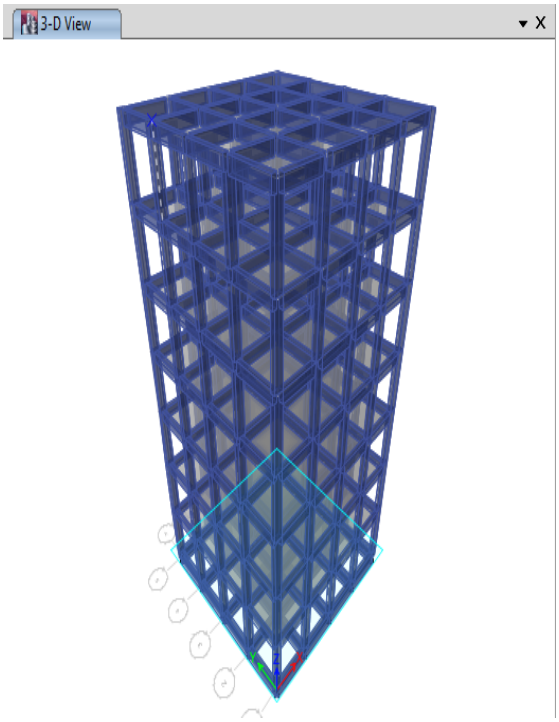


**Fig 2 3-D view of project model**

## IV. RESULTS AND DISCUSSIONS

The time period varies based on the stiffness criteria. Varying the column dimensions add to the stiffness of the structure. Hence the changes in time period are studied considering various parameters.

As per the formula provided in IS code (IS 1893(part1):2002), the time period value obtained,

$$\mathbf{Ta} = \mathbf{0.075}h^{\mathbf{0.75}}$$

= 0.7475 sec

Where h=height of the building in the model provided

h=21.45m

The above calculation is done manually just considering the overall height of the building. Here the formula is considered for a moment resisting RC frame building without brick infill wall. Hence the formula just considers the height of the building and not the base dimension.

a) Column dimensions:

The column dimensions are varied from model to model and the changes in time period is studied.

The column dimensions taken for model 1 = 230x500mm

The column dimensions taken for model 2 = 230x450mm

The column dimensions taken for model 3 = 230x230mm

Varying the column dimensions from model 1 to model 3 as mentioned above the changes in time period is noted.

**Table 1 Time period values for variation in column dimension consideration as per IS code & ETABS**

| COLUMN DIMENSIONS | TIME PERIOD -IS CODE (sec) | TIME PERIOD – ETABS (X-AXIS) (sec) | TIME PERIOD – ETABS (Y-AXIS) (sec) |
|---|---|---|---|
| 230x500mm | 0.7475 | 0.871 | 1.368 |
| 230x450mm | 0.7475 | 0.937 | 1.421 |
| 230x230mm | 0.7475 | 1.853 | 1.853 |

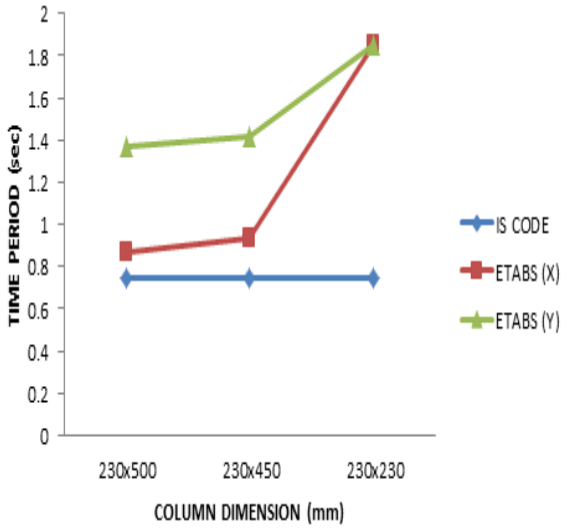


**Fig 3 Graph indicating time period values for variation in column dimension consideration as per IS code & ETABS**

The results show that as the dimensions of columns are increased (the depth of column is increased) the time period of the building model shown reduces. This shows that column dimensions contribute to the stiffness of the structure and hence the time period reduces with the increase in stiffness.

b) Slab dimensions:

The slab dimensions are varied from model to model. The slab dimensions are taken as 130mm, 150mm, 200mm (0.13m, 0.15m and 0.2m respectively).

**Table 2 Time period values for variation in slab dimension consideration as per IS code & ETABS**

| SLAB DIMENSION | TIME PERIOD -IS CODE (sec) | TIME PERIOD – ETABS (X-AXIS) (sec) | TIME PERIOD – ETABS (Y-AXIS) (sec) |
|---|---|---|---|
| 130mm | 0.7475 | 0.937 | 1.421 |
| 150mm | 0.7475 | 0.938 | 1.43 |
| 200mm | 0.7475 | 0.939 | 1.45 |

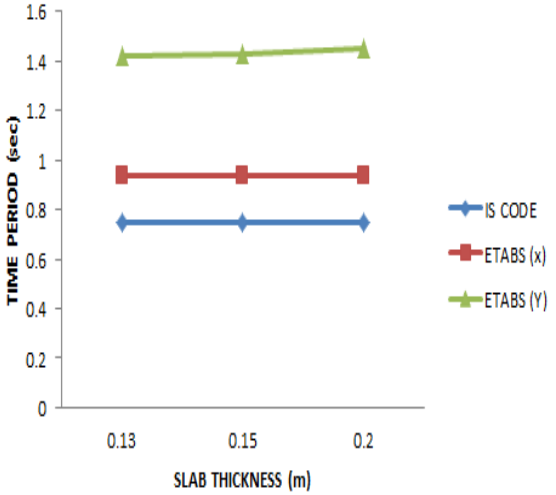


**Fig 4 Graph indicating time period values for variation in slab dimension consideration as per IS code & ETABS**

The variation in slab thickness does not show changes in time period values. Hence we get a straight line in the graph shown in Fig 4. The values remain constant as per the results obtained through the ETABS software. The slab being an horizontal component is not considered for the stiffness criteria and hence this parameter does not affect time period.

c) Grade of concrete:

Beams and slabs are provided with same grade of concrete since they are casted together. Columns are provided with higher grade of concrete since they add to the stiffness of the structure.

**Table 3 Time period values for grade of concrete consideration as per IS code & ETABS**

| GRADE OF CONCRETE | TIME PERIOD -IS CODE (sec) | TIME PERIOD – ETABS (X-AXIS) (sec) | TIME PERIOD – ETABS (Y-AXIS) (sec) |
|---|---|---|---|
| M20 | 0.7475 | 0.948 | 1.463 |
| M25 | 0.7475 | 0.937 | 1.421 |
| M30 | 0.7475 | 0.922 | 1.409 |

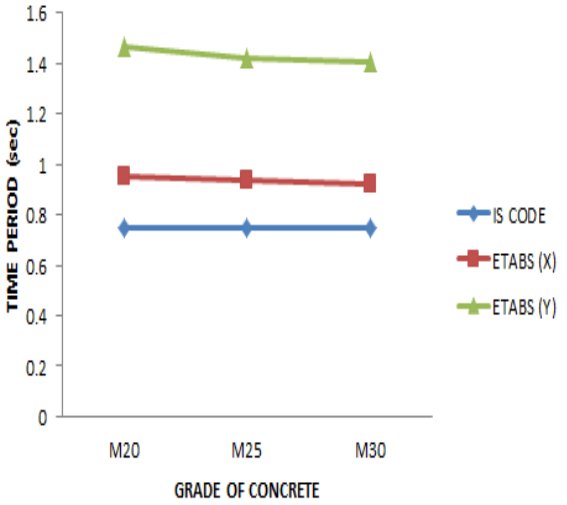


**Fig 5 Graph indicating time period values for grade of concrete consideration as per IS code & ETABS**

The grade of concrete does not show any variation in time period values. The grade of concrete contributes to the strength of the structure it does not add to the stiffness of the structure.

d) Orientation of columns:

The columns are oriented in 2 directions just to study the impact of time period. In one model the larger dimension of columns is oriented parallel to the X-axis and in another model the larger dimension of columns is oriented along the Y-axis.

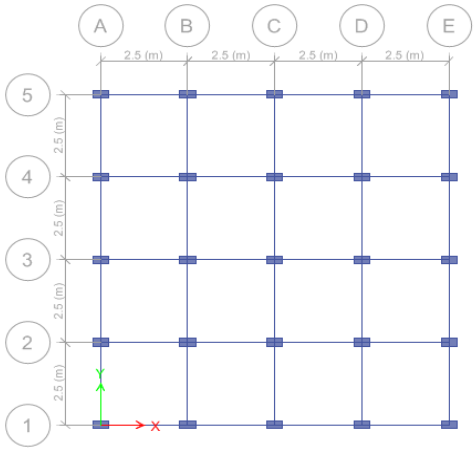


**Fig 6 Orientation of columns (larger dimension) parallel to X-axis**

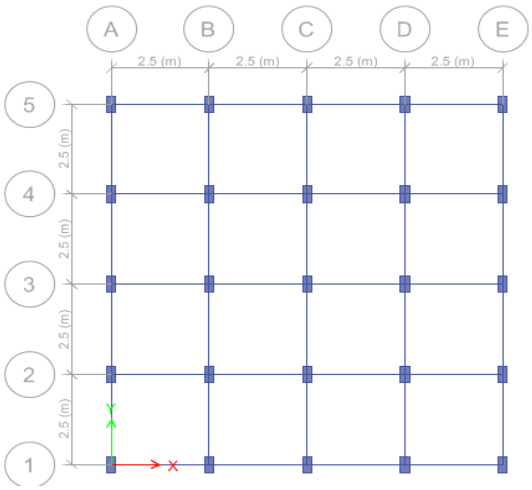


**Fig 7 Orientation of columns (larger dimension) parallel to Y-axis**

Time period value (X-axis) for Fig.6 model=0.937sec Time period value (Y-axis) for Fig.6 model=1.421sec Time period value (X-axis) for Fig.7 model=1.405sec Time period value (Y-axis) for Fig.7 model=1.059sec

It is observed that the columns oriented along larger dimension will show less time period values along that axis due to the increase in stiffness.

## V. APPLICATION IN STRUCTURAL ENGINEERING

In this paper parametric study is done on time period considering the main criteria for time period as stiffness. This study helps in producing earthquake resistant design structures and also provides an importance for the time period which is an important criterion for determining the effect of earthquake and hence evaluating the base shear.

## VI. SCOPE OF WORK

- The future research or scope of work is carried out on factors such as dimensions of beams, number of bays, number of storeys, different loading criteria, zones, soil type, variation in each storey height etc.
- The factors affecting time period and the factors not affecting time period are studied.

## VII. CONCLUSIONS

- It was studied that not only height of the building but also other parameters affect the time period.
- When we considered the orientation of the columns it was observed that ETABS software considers the time period formula relating the base dimension and overall height of the structure. Though we do not provide infill walls the software assumes it to be infill wall.
- Considering orientation of columns larger dimension side of columns will show high stiffness and hence will have less time period.
- The slab thickness and the grade of concrete does not affect the time period of the structure. Since slab thickness is the horizontal component and does not add to stiffness and grade of concrete adds to the strength of the structure.

## VII. REFERENCES

[1] IS 1893 (Part 1) : 2002 – Criteria for Earthquake Resistant Design of Structures, part 1 general provisions and buildings, Bureau of Indian Standards, New Delhi, 2002

[2] Magdy I. Salama, Estimation of period of vibration for concrete moment-resisting frame buildings, HBRC Journal, pp. 16-21, 2015

[3] K. Rama Raju, M.I. Shereef, Nagesh R Iyer, S. Gopalakrishnan, Analysis and Design of RC Tall Building subjected to Wind and Earthquake Loads, The Eighth Asia-Pacific Conference on Wind Engineering, December 10–14, 2013, Chennai, India

[4] Rajmane Ashvini M, Determination of the Fundamental Period of Vibration of Multi-Storey RC Buildings, Journal of Civil Engineering and Environmental Technology, vol. 2, Number 8; April-June, 2015