

## **Time History Analysis and Design of Multistoreyed Building**

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### **Abstract:**

**Seismic activity**, of an area is the frequency, type, and size of earthquakes experienced over a period of time. Structural Analysis is the branch which involves in the determination of behaviour of structure in order to predict the responses of different structural components due to effect of loads.

Time history method gives all possible forces which are generated, and there by displacement of structure, during entire duration of ground motion at equal interval, typically 0.05to 0.1sec. STAAD. Pro is a structural analysis design program software. To get some idea about the handling of an integral building design software like staadpro and study of seismic forces responses on building life cycle and to define the analyse behaviour of building using time history analysis. This project deals with the identification of bending and shear forces due to several load conditions. i.e., Analysis and also deals with the design of sections to increase the serviceability of the G+7 storey building. This paper gives time history analysis by using time-acceleration data as input function and then performance of the structure is evaluated with various mode shapes and time-acceleration results.

**Keywords:** *Staadpro, Time History Analysis, Design, Multistoreyed, Building*

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### **I. INTRODUCTION**

Due to fast urbanization construction of a large number of multi-storeyed buildings, many existing RC buildings located in seismic zones are deficient to withstand earthquakes. A large portion of India is susceptible to damaging levels of seismic hazards. Seismic safety of these building is of importance. Hence, it is necessary to take in to account the seismic load for the design of high-rise buildings. Seismic loads are required to be carefully modelled so as to assess the real behaviour of structure with a clear understanding that damage is expected but it should be regulated.

1. Time history method gives all possible forces which are generated, and there by displacement of structure, during entire duration of ground motion at equal interval, typically 0.05to 0.1sec.
2. Time-history analysis is the behavioural study of a structure under a past earthquake or wind acceleration data. Structure need not be SDoF system. Time-history is a plot of amplitude or acceleration vs time.
3. In time history analyses the structural response is computed at a number of subsequent time instants. In other words, time histories of the structural response to a given input are obtained a result. In response spectrum analyses the time evolution of response cannot be computed.
4. Structural Analysis is the branch which involves in the determination of behaviour of structure in order to predict the responses of different structural components due to effect of loads.

#### **1.1 INTRODUCTION TO STAAD-PRO SOFTWARE-**

- STAAD. Pro is a structural analysis design program software.
- It is used for 3D model generation, analysis and multi-material design.
- The commercial version of STAAD. Pro supports several steel, concrete and timber design codes.
- It is one of the software applications created to help structural engineers to automate their tasks and to remove the tedious and long procedures of the manual methods.

#### **1.2 HISTORY OF STAAD.PRO-**

- STAAD. Pro was originally developed by Research Engineers International in 1997 Yorba Linda, CA.
- In late 2005, Research Engineer International was bought by Bentley Systems.
- Bentley systems is an American Software development company that is actively engaged in developing and marketing software products for the design, construction and operation of infrastructure.

**1.3 VARIOUS CODES USED IN DESIGN-**

- **IS-456:2000:-** Design code for RCC structures.
- **IS-875(PART1):** - Design code for dead load.
- **IS-875(PART2):** - Design code for imposed load.
- **IS-1893:2002:** - Design code for seismic load.
- **SP-34:** - Detailing code for structures.

**1.4 STRUCTURE -**

• A structure can be defined as an assemblage of elements. STAAD is capable of analysing and designing structures consisting of both frame and finite elements. Almost any type of structure can be analysed by STAAD Pro.

- Frame elements- Beam elements- 2 nodes
- Finite elements- 1) Plate – 3 or 4 nodes  
2) Solid – 4 to 8 nodes

• In case of STAAD

- i. Node becomes Joint ➡ it has a number and its coordinate
- ii. Beam becomes Member ➡ it has a number and nodes at its end
- iii. Plate becomes Element ➡ B it has a number and node at its Corner

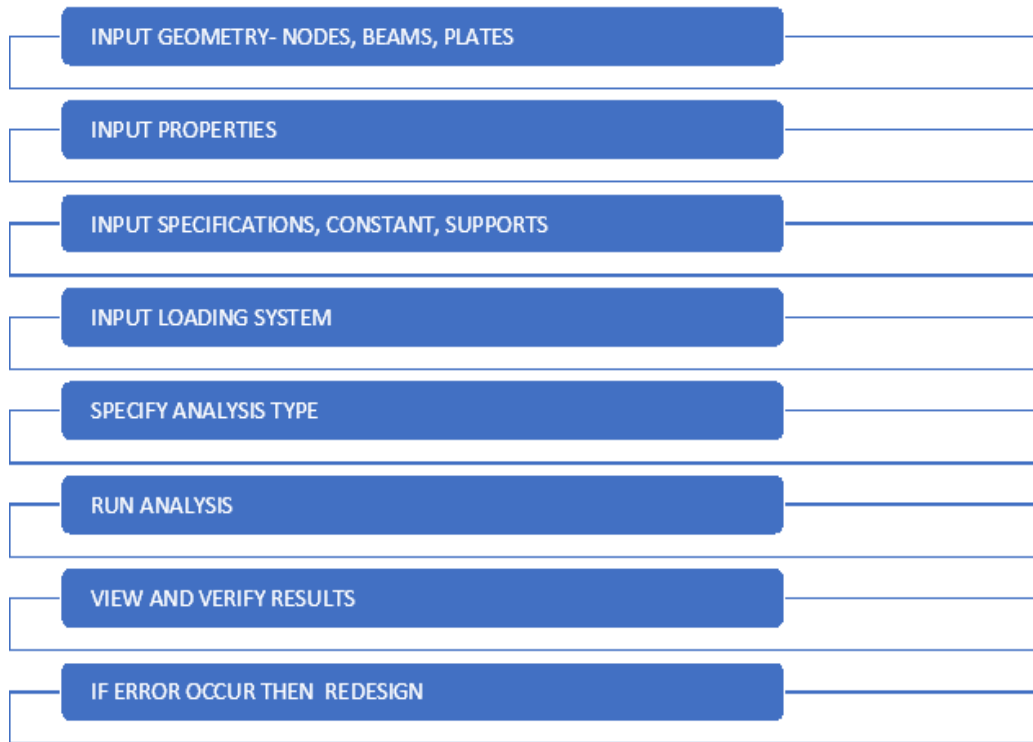
**1.5 STUDY OF PROBLEM STATEMENT:**

- Time history is basically a method of seismic analysis for the simulation of an earthquake motion.
- It is an ultimate tool to study the dynamic response of a structure.
- This paper gives time history analysis by using time-acceleration data as input function and then performance of the structure is evaluated with various mode shapes and time-acceleration results.

Type of structure	High rise RCC frame structure
Occupancy	office building
Number of storeys	7
Foundation depth	5m
Intermediate storey height	3m
Type of soil	soft soil
Length of Building	18m
Height of Building	24m
No. of bays along length	6
No. of bays Along Height	8
No. of bays along width	4
Column Size	0.50m × 0.50m
Beam Size	0.35m × 0.35m
Slab Thickness	0.125 m
Dead Load	1 kN/m <sup>2</sup>
Live Load	3 kN/m <sup>2</sup>

## II. PLAN OF WORK

### 2.1 MODEL GENERATION AND DESIGN STEPS: -



#### 2.1.1 Modelling of The Building:

- One of the objectives of this model designing is to ensure that the model represent the characteristics of Highrise buildings.
- Buildings with different number of stories with 7 storeys having same floor Plan of dimensions were considered for this study.
- The floor plans were divided into six by four bays in such a way that centre to centre distance between two grids is 5 meters by 5 meters respectively as shown in figure 1. The floor height of the building was assumed as 3 meters for all Floors and plinth height is 5 meters above from foundation base as shown in figure.

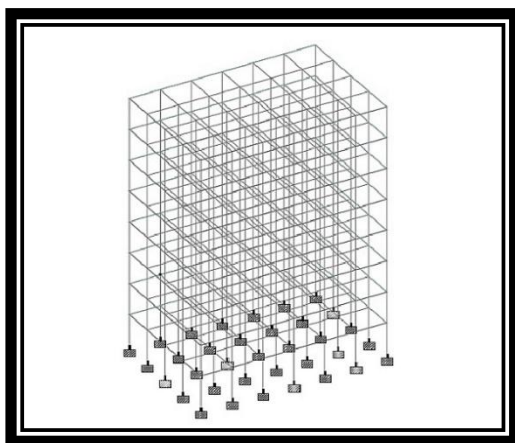


Fig. 2.1.1 Elevation of the Structure

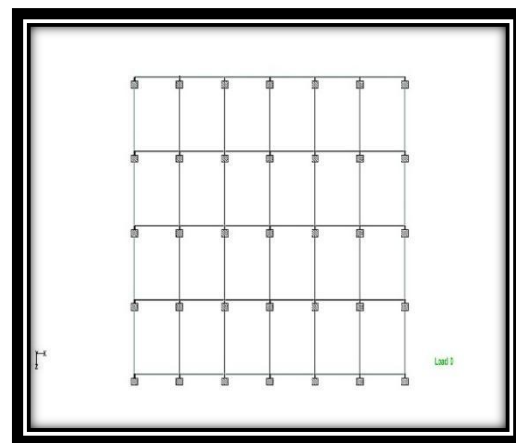


Fig.2.1.2 Plan of the Structure

#### 2.1.2 Assigning Property:

- Assigning a property means to provide dimensions such as width, thickness etc. to beams, columns, slabs etc.

- This work is done by using Property page in the tool bar.

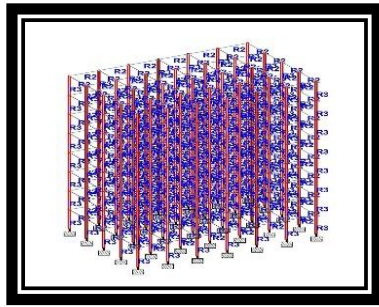


Fig.2.1.2 Assigning Columns

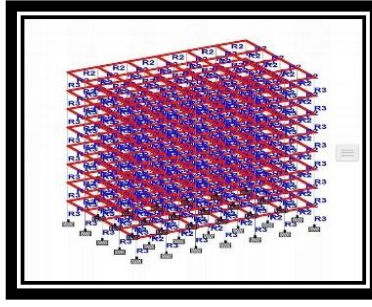


Fig.2.1.3 Assigning Beams

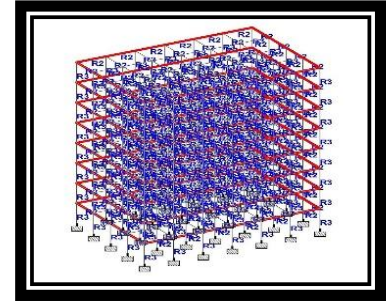


Fig.2.1.4 Assigning Plate

**2.1.3 Assigning Supports -** There are three types of supports provided to a structure :-

1. Fixed support
2. Pinned support
3. Roller support

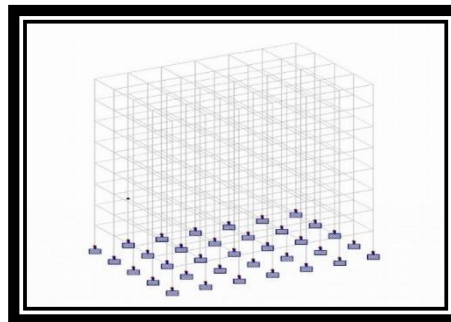


Fig.2.3.1 Assigning Fixed Supports

**2.1.4 ASSIGNING LOADS-**

- Any structure is subjected to basically these types of loads-
1. Dead Load
  2. Live Load

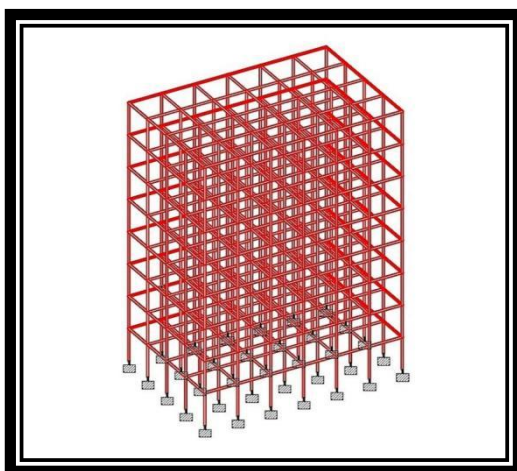


Fig2.4.1.After Applying Dead Load

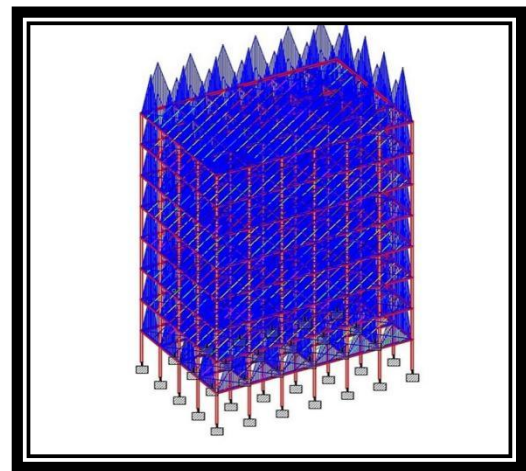
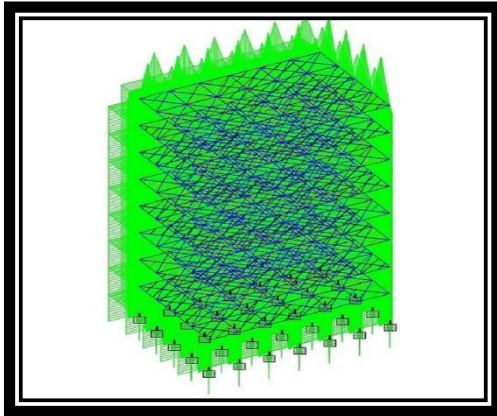


Fig2.4.2 After Applying Live Load (Imposed)

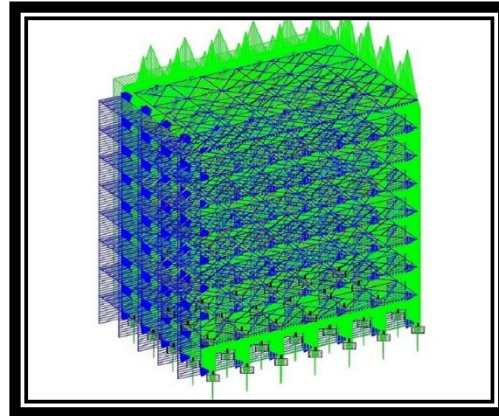
**2.2 Time History Analysis Steps:**

- After creating model next step is time history Analysis.
- Assign Support Conditions to restrained joints.
- Select Define>Functions>Time History to define a time history function which characterizes load variation over time.
- Assign load conditions to the model through assign > joint loads or frame loads.

- Define either a modal or direct integration time history load case through define > load cases.
- To customize load application, enter, on the load case data form under load applied, the following fields:
  - **Load Type:** Select the load pattern option
  - **Load Name:** Select the, load pattern to be applied.
  - **Function:** Select the time function which characterizes load variation in time.



**Fig.3.1.1 Time History Analysis (Ground Motion )**



**Fig.3.1.2 Time History Analysis (GX Direction)**

**2.3 IF ERROR OCCURS THEN REDESIGN THE MODEL-**

**III. RESULT AND DISCUSSION**

MODE	CALCULATED FREQUENCIES FOR LOADCASE FREQUENCY(CYCLES/SEC)	PERIOD(SEC)
1	0.977	1.02360
2	1.036	0.96533
3	1.069	0.93514
4	3.054	0.32745
5	3.213	0.31128
6	3.347	0.29877

A frequency is the number of cycles of vibration the system undergoes in a unit of time which is expressed in Hertz(Hz)or (Cycles per sec). when a structural system is undergoing undamped vibration in its natural state (under self excitation), it is said to be undergoing free vibration. A structure has as many natural frequencies as its degree of freedom, but the frequency with highest mass participation factor is often regarded as the natural frequency.

**MASS PARTICIPATION FACTORS IN PERCENT**

MODE	X	Y	Z	SUMM-X	SUMM-Y	SUMM-Z
1	0.00	0.00	0.00	0.000	0.000	0.000
2	0.00	0.00	79.86	0.000	0.000	79.864
3	80.22	0.00	0.00	80.217	0.000	79.864
4	0.00	0.00	0.00	80.217	0.000	79.864
5	0.00	0.00	10.20	80.217	0.000	90.061
6	10.24	0.00	0.00	90.457	0.000	90.061

**ACTUAL MODAL D A M P I N G USED IN ANALYSIS**

MODE	DAMPING
1	0.0500
2	0.0500
3	0.0500

4	0.0500
5	0.0500
6	0.0500

- By Default, Staad takes 5% damping, i.e., DM is 0.05 for which the multiplying factor is 1(as per IS 1893-2002)
- The maximum value of damping given in code (table 3 of IS 1893-2002) is 30%, i.e., DM is 0.3 for which the multiplying factor is 0.5. as this value exceeds the max value, staad takes the maximum value i.e., damping of 30% (correspondingly multiplying factor is 0.5)
- Using staad pro software, the design consideration has been taken as per the IS codes. The design is safe in all conditions.
- The design of Slab, Beam Column are done in limit state method which is safe at control of deflection and in all aspects.
- It is observed that Time history analysis is realistic method, used for seismic analysis, it provides a better check to the safety of structures analysed and designed by method specified by Is code.

#### **IV. CONCLUSION**

- By doing this project we have get idea about handling of an itegral building design software i.e.,Staadpro and we have also studied the seismic force responses on building life cycle and behaviour of building using time history analysis.
- The modal calculation for building is performed and natural frequency for different mode shapes of the building is obtained.
- The building G+7 structure is designed and time history analysis is performed.

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