DYNAMIC ANALYSIS OF MULTISTORIED RC FRAMED STRUCTURES

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Abstract: The important objective of engineers is to design and build a structure in such a way that damage to the structure and its structural component during the earthquake is minimize. The most sensitive issues that the Structural Engineers face is the selection of proper procedure for estimating the seismic performance of the structure. This is very important when they are dealing with high rise structures as the improper selection of the method ultimately leads to the results which are far away from the correct results. Dynamic analysis is one of the effective procedures for evaluating the seismic performance of the building. The damage control is one of important design considerations which is increasing its influence and can be achieved only by introducing dynamic analysis in the design. The dynamic analysis can be done by softwares .Stadd Pro is one of the leading software which is presently using by many companies and Structural Engineers for their projects. In this paper, for the dynamic analysis, a plan of a multi-storey building is taken and it has been modelled with different structural elements for minimum storey displacement. The Analysis of building using stadd pro and the dynamic analysis of multi-story buildings is done using Etabs by IS and SP codal provisions. The multi-storey building is R.C.C. structure with ground floor +7 upper floors in zone V with a maximum earth fill of 750 mm on the ground floor for landscape requirements. By comparing the results of dynamic analysis, the performance of the structural system can be evaluated.

Keywords:—Rcc Building frame, stadd pro, Dynamic analysis, multistoried building.Storey drift.

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1 Introduction

Earthquake has always been a threat to human civilization from the day of its existence, devastating human lives, property and man-made structures.Earthquake causes random ground motions, in all possible directions emanating from the epicentre. Vertical ground motions are rare, but an earthquake is always accompanied with horizontal ground shaking. The ground vibration causes the structures resting on the ground to vibrate, developing inertial forces in the structure. As the earthquake changes directions, it can cause reversal of stresses in the structural components, that is, tension may change to compression and compression ma change to tension. Earthquake can cause generation of high stresses, which can lead to yielding of structures and large deformations, rendering the structure non-functional and unserviceable. There can be large storey drift in the building, making the building unsafe for the occupants to continue living there.

Reinforced Concrete frames are the most common construction practices in India, with increasing numbers of high-rise structures adding up to the landscape. There are many important Indian cities that fall in highly active seismic zones. Such high-rise structures, constructed especially in highly prone seismic zones, should be analyzed and designed for ductility and should be designed with extra lateral stiffening system to improve their seismic performance and reduce damages.

Computers can perform complicated computations at a high speed therefore computer programs are used for analysis and design of structural member. Hand computations are applicable for small problem and tedious for even for medium sized calculations and 3-D analysis is almost impossible. . On the other hand in computer analysis 3-D analysis can be easily performed with a high degree of accuracy. STAAD Pro V8i, E tabs, Sap 2000 are very powerful which can be used for 3-D analysis and is useful for analysis and design of multi-storied buildings.

Seismic design involves two distinct steps:

a) Determining or estimating the structure forces that will act on the structure

b) Analyzing the structure to provide adequate strength, stiffness, and energy dissipation capabilities to withstand these forces.

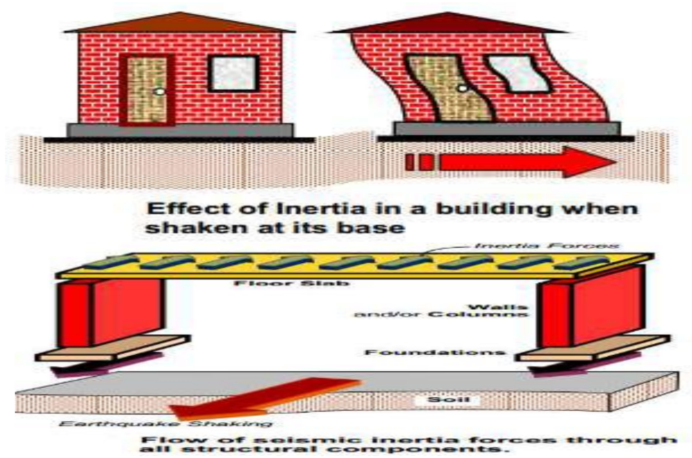


Fig 1 Earthquake effects

2 OBJECTIVES

- The goal of this project is the to investigate and determining the various structural response of the rc framed structure
- To find the appropriate methods for dynamic analysis
- Check the seismic response of building using Software
- To analyze lateral displacement, storey drift under loads

- To find the relationship between earthquake intensities and response

3 LITERATURE REVIEW

BahadorBagheri, [1], in this paper a Multi-storey irregular buildings of 20 stories had been analyzed. This paper also deals with the effect of the variation of the building height on the structural response of the shear wall building The first floor is of 3m and the rest are of 3.2 m. Static and dynamic analysis is carried out The results obtained by the equivalent static analysis gives maximum displacement and maximum displacement of center of mass in X & Y direction as compared to response spectrum and time history analysis.

Mohit Sharma, [2], in this paper problem taken is on a G+30 storied regular building. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software. RCC frame structure is analyzed both statically and dynamically. It can be concluded that the results as obtained for the Dynamic Analysis are higher than the values as obtained by Static Analysis for the same points and conditions.

AnirudhGottala, Kintali Sai Nanda et al [3] carried out comparative study of static and dynamic seismic analysis of a multi-story building. A multi-storied framed structure of (G+9) pattern is selected. Linear seismic analysis is done for the building by static method (Seismic Coefficient Method) and dynamic method (Response Spectrum Method) using STAAD-Pro as per the IS-1893-2002-Part-1. A comparison is done between the static and dynamic analysis, the results such as Bending moment, Nodal Displacements, Mode shapes are observed, compared and summarized for Beams, Columns and Structure as a whole during both the analysis.

B. Srikanth and V. Ramesh [4] comparative study of seismic response for seismic coefficient and response spectrum methods. In this thesis, the earthquake response of symmetric multi-storied building by two methods are studied. The methods include seismic coefficient method as recommended by IS Code and modal analysis using response spectrum method of IS Code in which the stiffness matrix of the building corresponding to the dynamic degrees of freedom is generated by idealizing the building as shear building. The responses obtained by above methods in two extreme zones as mentioned in IS code i.e. zone II and V are then compared. Test results Base Shears, Lateral Forces and Storey Moments are compared.

Mr. S.Mahesh, Mr. Dr.B.Panduranga Rao et al [5] the behaviour of G+11 multi-story building of regular and irregular configuration under earth quake is complex. In this paper a residential of G+11 multi-story building is studied for earth quake and wind load using ETABS and STAAD PRO V8i. Assuming that material property is linear static and dynamic analysis are performed. These analysis are carried out by considering different seismic zones and for each zone the behaviour is assessed by taking three different types of soils namely Hard, Medium and Soft. Different response like story drift, displacements base shear are plotted for different zones and different types of soils.

Girum Mindaye et al. [6] studied Dynamic story shear is less than static story shear for all cases. The base shear, lateral force, story shear, maximum story displacement and overturning moment are increased in both directions (i.e., X & Y) as the seismic zone goes from II to V for the same frame type building in both methods.

4 METHODS OF ANALYSIS

4.1. Response spectrum method

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002(part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2013 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).

ZONE FACTORS FOR DIFFERENT ZONES IN INDIA Zone	Seismic coefficient of 1984	Seismic zone factor (z of 2002)
V	0.08	0.36
IV	0.05	0.24
III	0.04	0.16
II	0.02	0.1

Table 1 Zone factors for different zones

4.2. STAAD:

Staad is powerful design software licensed by Bentley. Staad stands for structural analysis and design.

4.3 Procedure

In order to study the effect of earthquake on a g+7 building a computer aided designing software namely staad pro v8i has been used. This software is very fast as compared to manual designing.

1. **Input data**: The staad pro provides an input file which is a text file and it consists all the commands executed in a sequence. This text file consist instructions for analysis and design.
2. **Modeling of structure**: The structure is modeled by giving coordinates, by providing building height, floor height, material constants, supports etc.
3. **Materials**: Materials selection was done by the software itself
4. **Supports**: All the supports provided in the structure are fixed
5. **Loads**

- **Load Cases**: Load cases are generated by software and are accordance with Indian standards.
- **Seismic load**: These loads are applied in X-direction and in Z-direction in staad pro. These loads will simulate the building as in actual condition during earthquake. All the loading is done with the accordance with IS – 1893.
- **Dead load**: These loads are non-movable loads and are fixed like weight of beams and columns, floor weight, slab weight etc.

- **Live load**: These loads are movable load like human being in building.
- **Design parameter**: The designing is performed as per IS: 456 for concrete design, IS: 13920 for ductile detailing of reinforced concrete design and IS: 1893 for seismic parameter.

6. **Analysis of structure**: The whole structure was analyzed by the software under consideration of IS: 1893 for seismic parameter.

5 PROBLEMS UNDERTAKEN

The Building located at kalmandapam junction at Palakkad. And it has 7 storeys. Constructed for the purpose of shopping mall.

5.1 Building properties

5.1.1. Site Properties:

- Details of building: G+7 RC structure
- Outer and inner wall thickness: 200 mm
- Floor height: 3.6 m
- Height of the building: 28.8 m

5.1.2 Seismic Properties:

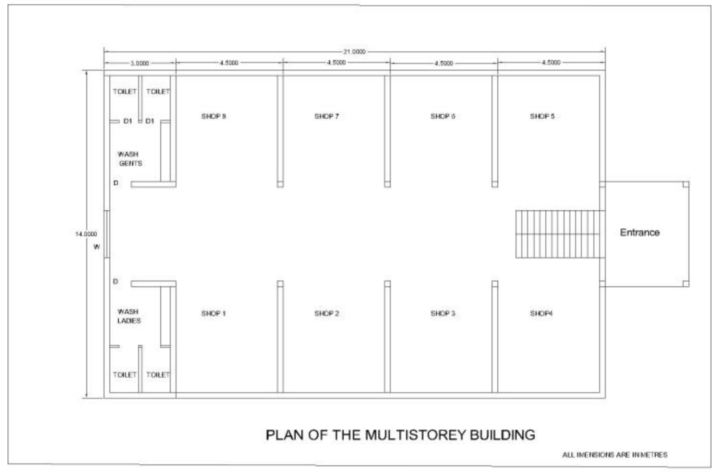
- Seismic zone: V
- Zone factor: 0.36
- Importance factor: 1
- Response Reduction factor R: 5
- Soil Type: Hard soil

5.1.3 Material Properties

- Material grade of M30 used for the analysis.
- Loading on structure
- Dead load: self-weight of structure including infill.
- Wind load: As per IS 875(Part 3) 1987
- Seismic load: Seismic Zone –V
- Size of column – 450mm*450mm
- Size of beams – 300mm*400mm in longitudinal and 300mm*400mm in transverse direction

5.1.4. Load properties

- Live load-3KN/M2
- Specific weight Of RCC-25N/M2



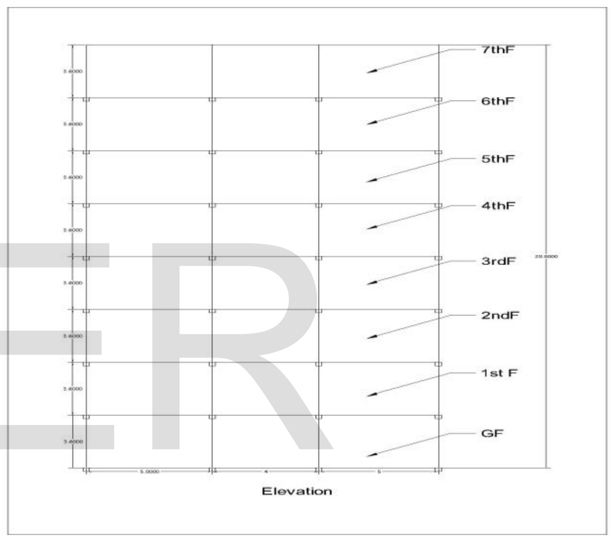


Fig 2 plan and Elevational view of the building

6 RESULTS

The above rcc frame is analysed dynamically and results are compared

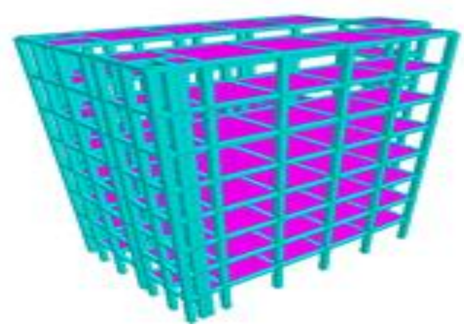


Fig 3 Rendered view of the building

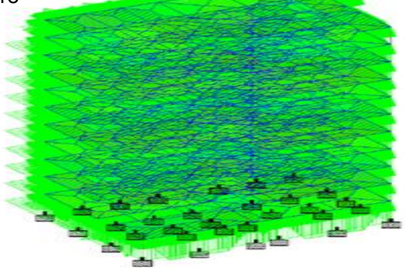


Fig 4 response spectrum loading

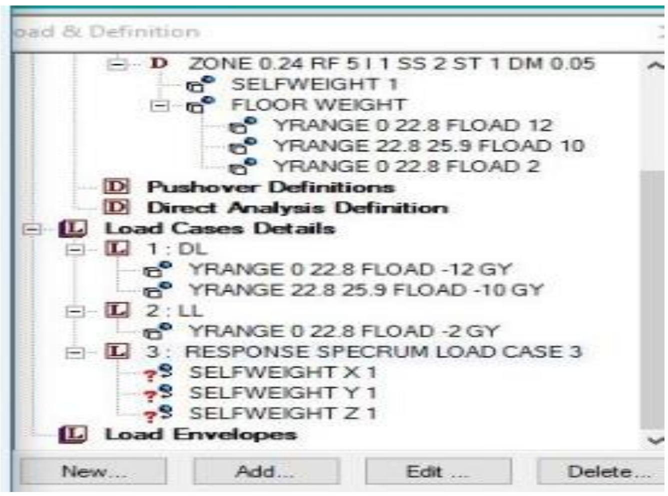


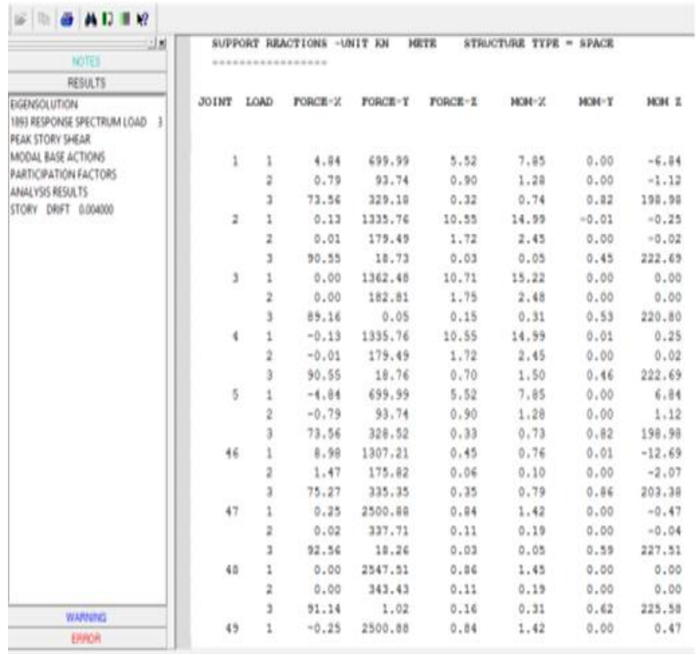
Fig 5 response spectra load cases

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	19	1:dl	**4.974**	998.460	-0.686	-1.268	-0.038	-5.375
Min FX	8	1:dl	**-4.922**	1.44E+3	0.639	0.976	-0.004	6.427
Max FY	25	1:dl	-0.499	**1.77E+3**	-5.378	-6.013	-0.012	1.192
Min FY	34	2:ll	0.116	**149.677**	-0.092	-0.158	-0.003	-0.138
Max FZ	32	1:dl	-0.493	1.47E+3	**7.537**	9.159	-0.011	1.165
Min FZ	29	1:dl	-0.500	1.42E+3	**-6.687**	-8.139	-0.044	1.230
Max MX	32	1:dl	-0.493	1.47E+3	7.537	**9.159**	-0.011	1.165
Min MX	30	1:dl	0.584	1.35E+3	-6.593	**-8.152**	-0.027	-0.121
Max MY	34	1:dl	0.798	421.644	-0.662	-1.254	**0.172**	-0.469
Min MY	12	1:dl	0.418	444.638	1.346	1.535	**-0.124**	-0.049
Max MZ	8	1:dl	-4.922	1.44E+3	0.639	0.976	-0.004	**6.427**
Min MZ	19	1:dl	4.974	998.460	-0.686	-1.268	-0.038	**-5.375**

Table 2 Reaction summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	297	1:dl	**2.592**	-1.398	0.517	2.990	-0.000	0.000	-0.000
Min X	313	2:ll	**-0.025**	-0.729	-0.076	0.733	0.000	0.000	0.000
Max Y	1	1:dl	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000
Min Y	321	1:dl	1.993	**-6.452**	0.204	6.756	-0.000	0.000	-0.000
Max Z	309	1:dl	1.802	-1.786	**0.701**	2.632	0.000	0.000	-0.000
Min Z	303	1:dl	1.978	-3.063	**-0.624**	3.700	0.000	0.000	0.000
Max rX	328	1:dl	1.731	-5.369	0.204	5.645	**0.000**	0.000	-0.000
Min rX	325	1:dl	2.506	-5.217	-0.118	5.789	**-0.000**	0.000	-0.000
Max rY	330	1:dl	2.591	-1.562	0.379	3.049	-0.000	**0.000**	-0.000
Min rY	108	1:dl	0.193	-0.644	0.086	0.677	0.000	**-0.000**	-0.000
Max rZ	304	1:dl	1.981	-5.140	-0.345	5.519	0.000	0.000	**0.000**
Min rZ	315	1:dl	2.336	-3.516	0.286	4.231	-0.000	0.000	**-0.001**
Max Rst	321	1:dl	1.993	-6.452	0.204	**6.756**	-0.000	0.000	-0.000

Table 3 Node displacement summary



SUPPORT REACTIONS -UNIT KN METE STRUCTURE TYPE = SPACE

JOINT	LOAD	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM Z
1	1	4.84	699.99	5.52	7.85	0.00	-6.84
	2	0.79	93.74	0.90	1.28	0.00	-1.12
	3	73.56	329.18	0.32	0.74	0.82	198.98
2	1	0.13	1335.76	10.55	14.99	-0.01	-0.25
	2	0.01	179.49	1.72	2.45	0.00	-0.02
	3	90.55	18.73	0.03	0.05	0.45	222.69
3	1	0.00	1362.48	10.71	15.22	0.00	0.00
	2	0.00	182.81	1.75	2.48	0.00	0.00
	3	89.16	0.05	0.15	0.31	0.53	220.80
4	1	-0.13	1335.76	10.55	14.99	0.01	0.25
	2	-0.01	179.49	1.72	2.45	0.00	0.02
	3	90.55	18.76	0.70	1.50	0.46	222.69
5	1	-4.84	699.99	5.52	7.85	0.00	6.84
	2	-0.79	93.74	0.90	1.28	0.00	1.12
	3	73.56	328.52	0.33	0.73	0.82	198.98
46	1	8.98	1307.21	0.45	0.76	0.01	-12.69
	2	1.47	175.82	0.06	0.10	0.00	-2.07
	3	75.27	335.35	0.35	0.79	0.86	203.38
47	1	0.25	2500.88	0.84	1.42	0.00	-0.47
	2	0.02	337.71	0.11	0.19	0.00	-0.04
	3	92.56	18.26	0.03	0.05	0.59	227.51
48	1	0.00	2547.51	0.86	1.45	0.00	0.00
	2	0.00	343.43	0.11	0.19	0.00	0.00
	3	91.14	1.02	0.16	0.31	0.62	225.58
49	1	-0.25	2500.88	0.84	1.42	0.00	0.47

Fig 6 Joint displacements

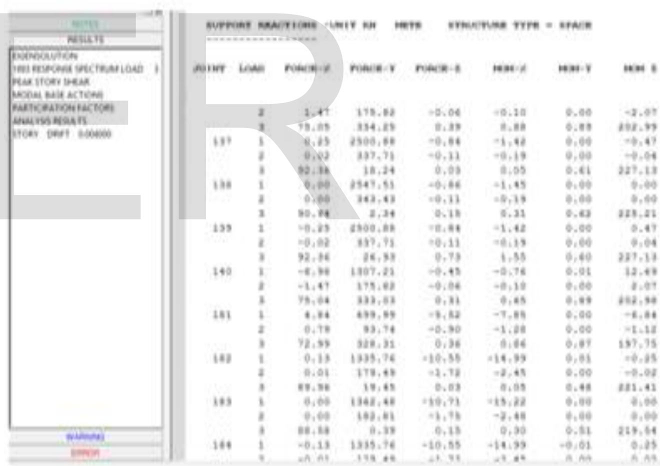


Fig 7 Support reactions

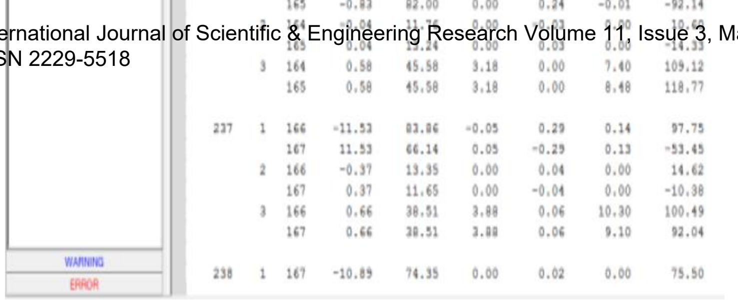


Fig 8 Member forces

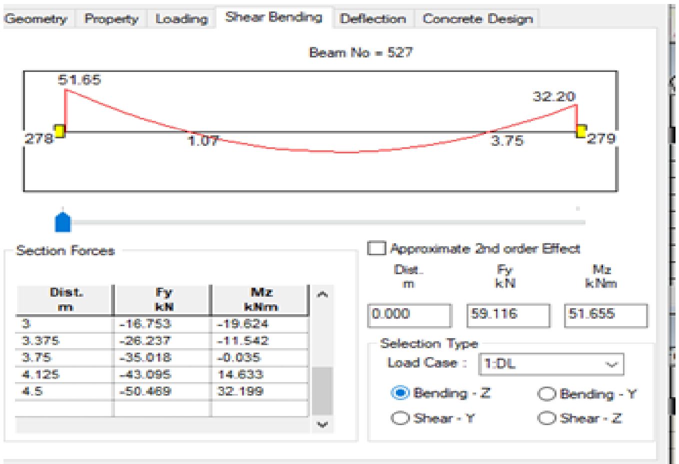


Fig 9 shear bending diagram

L/C		FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
1:dl	Loads	0.000	-36.3E+3	0.000	-540E+3	0.000	-1.11E+6
1:dl	Reactions	-0.000	36.3E+3	0.000	540E+3	-0.000	1.11E+6
	Difference	-0.000	0.000	0.000	-0.000	-0.000	0.001
2:ll	Loads	0.000	-7.55E+3	0.000	-112E+3	0.000	-221E+3
2:ll	Reactions	-0.000	7.55E+3	0.000	112E+3	0.000	221E+3
	Difference	-0.000	0.000	0.000	-0.000	0.000	0.000

Table 4 Static check resuls

Fig 10 Base shear

7. CONCLUSIONS

- The response of (G+7) storey RC building under seismicload as per IS1893:2002 (Part-1) by using software STAAD -Pro has been studied. This analysis provides complete guidelines for STAAD-Pro software analysis of dynamic method. STAAD-Pro gives result very quickly as compared to manual calculation.
- Also Base shear, Lateral load, Joint displacement, support reaction and member forces for all the joints of a building has been calculated in STAAD output viewer.
- By using stadd pro software, it reduces the time in design and analysis work. In beam the bending moments, as the floor height increases the bending moment in the beam decreases
- The difference of values of displacement between static and dynamic analysis is insignificant for lower stories but the difference is increased in higher stories and static analysis gives higher values than dynamic analysis.
- Static analysis is not sufficient for high rise buildings and it's necessary to provide dynamic analysis**.**

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