STUDY ON THE SEISMIC BEHAVIOUR OF STRUCTURE (G+10) AT DIFFERENT ZONES USING STAAD PRO

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Abstract
High-rise buildings are primarily built and designed to provide serviceability, stability, and durability to the people who live in them. Several earthquakes in India have demonstrated that high-rise structures are collapsing and becoming vulnerable to earthquake damage. Engineers are needed today to design earthquake resistant structures for various seismic zones in order to reduce seismic damages in high-rise buildings. The structural configuration of a multi-story building, whether irregular or regular, exhibits different behaviour during a seismic event. The purpose of this research is to look into the variation in behaviour of a (G+10) multistory building structure with a regular (Rectangular or Square) structural configuration in different seismic zones (zones II to V) in India. The entire structure is examined with STAAD Pro software to access parameters such as base shear, storey shear, and storey drift for various seismic zones (zone II to V) seismic analysis of regular (rectangular or square) structural configurations Index Terms structural configurations, seismic analysis, Response Spectrum Method.
Keywords: High-rise buildings, STAAD Pro, Seismic zones, Response Spectrum Method, Zones II to V

Introduction
Earthquake load occurs as a result of the inertia force produced in the building as a result of seismic excitations. The inertia force varies with mass. The greater the mass of the structure, the greater the earthquake loading. When the earthquake load exceeds the element's moment of resistance, the structure will break or be damaged. The magnitude of earthquake loading is determined by the weight or mass of the building, its dynamic properties, and the stiffness difference between adjacent floors, as well as the intensity and duration of the earthquake. Earthquake force acts on the surface of a structure placed on the ground or on a structure adjacent to it.

Primary Function of a Structure
A structure's primary function is to receive loads (usually known as service loads) at certain points and safely transmit them to other points. A building frame, for example, receives occupancy loads in addition to the self-weight of the structural components of the building and safely transfers them to the foundations. In performing this primary function of receiving service loads and safely transferring them to other points. Internal forces develop in the structure's component members, known as structural elements. The failure may be caused by the inadequacy of one or more structural elements.

Classification Of Structures
The supporting systems of the structures define them. There is only one type of stress in a one-dimensional, two-dimensional, and three-dimensional supporting system. Then it is referred to as the basic system. When a system is subjected to multiple types of stress at the same time. Then it is referred to as a mixed system. 3 A one-dimensional supporting system, also known as a line supporting structure, is large in one dimension but small in the other two. The material continues to

be concentrated along a straight, curved, or angular line. Surface structure is another term for two-dimensional supporting systems. In two dimensions, the surface structure is large, but in three dimensions, it is small. The material remains dispersed across a surface. The surface of the curve may be plane of curved. The curved surface can have either a single or double curvature. A surface can also be made up of line elements that are joined together to form a continuous structure. The frame and shell structures are rigid curves with a surface structure. Three-dimensional structures are large in three dimensions and can have any shape. Space structures are another name for three-dimensional structures. Space structures are another name for three-dimensional structures. Space structures are also three-dimensional frame structures. The structures can also be classified into the three categories listed below.

(i) skeletal structures
(ii) stressed skin structures
(iii) solid structures

Skeletal structures can be idealised as a series of straight or curved lines. Roof trusses, lattice girders, and building frames are common examples of skeletal structures. Surface structures can be idealised as a skeleton or a plane c curved surface. In general, only the skeletal structure can be analysed using basic structural mechanics methods. Fortunately, the majority of commonly used structures can be classified as skeletal structures. The selected structures are further classified into two types.

(i) pin –jointed frames
(ii) rigid jointed frames

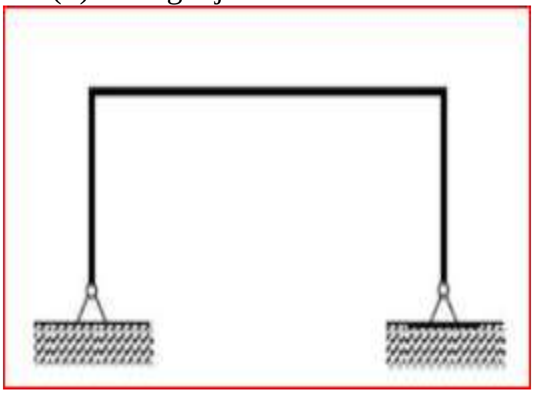


Fig1:Pin jointed frames

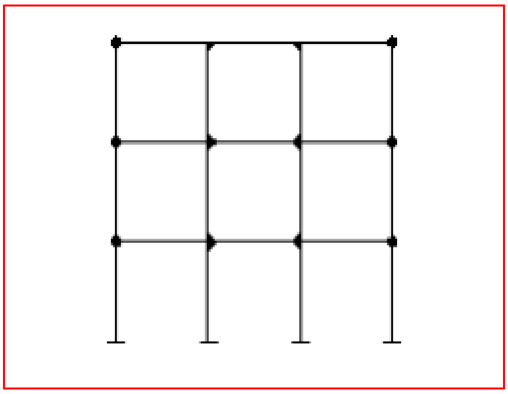


Fig2:Rigid jointed frames

Members of pin jointed frames are connected by developing only axial forces in the constituent members if external forces act on the joints and the members are straight, as the name implies. Unless otherwise stated, it is assumed that in the case of a pin-joint frame, external forces act at the joints and the members are straight. The joints of the rigid frames, on the other hand, are assumed to be rigid, so that the angles between the members meeting at a joint remain constant. These frames withstand external forces by generating bending moments, shear forces, axial forces, and twisting moments in their members.

Skeletal structures may also be classified as

(i) plane frames
(ii) space frames

All members of the plane frames as well as the external loads are assumed to be in one plane. If these frames are pin-jointed, the members carry only axial forces. On the other hand, if the frames are rigid – jointed, the members are subjected to axial forces, shear forces and bending moments. In the case of space frames do not lie in the plane. very often, space frames are subjected to axial forces only, if the joints are pin connected. On the other hand, the members of a rigid jointed space frame are subjected to axial forces, shear forces, bending moments and twisting moments.

Types Of Framed Structures

The framed structures can be divided into six categories: Beams, plane trusses, space trusses, plane frames. grids and space frames. the joints of a framed structure are points of intersection of the members, as well as points of support and the ends of members. I roads on a framed may be concentrated forces, distribution load or couples.

Types of frame structures

(a) Beam
(b) plane truss
(c) space truss
(d) plane frame
(e) Rigid
(f)space frame

Types Sesmic Analysis Methods

Equivalent Static Analysis

This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to "yielding" of the structure, many codes apply modification factors that reduce the design forces reduction.

Response Spectrum Analysis

This approach permits the multiple modes of response of a building to be taken into account (in the frequency domain). This is required in many building codes for all except very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonics". Computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building.

Combination methods include the following:

(a**) absolute** – peak values are added together
(b) square root of the sum of the squares (SRSS)
(c) complete quadratic combination (CQC) – a method that is an improvement on SRSS for closely spaced modes The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum. In cases where structures are either too irregular, too tall or of significance to a community in disaster response, the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static analysis or dynamic analysis.

Plan of G+10 Residential Building

Fig 2:Plan of G+10 Residential Building

Design Parameters

• Dead Load: Dead loads are permanent or stationary loads which are transferred to the structure throughout their life span. Dead loads mainly due to self-weight of structural members, permanent partitions, fixed equipment and fittings. These loads shall be calculated by estimating the quantity of each material and then multiplying it with the unit weight.

• Live Load: These are the loads that changes with respect to time. Live loads or imposed loads include loads due to the people occupying the floor, weight of movable partitions weight furniture and materials.

• There are also wind loads, earthquake loads and snow load. Also, floor finishes are considered as loads.

• **Shear Force:** The algebraic sum of the vertical forces at any section of a beam to the one side of the section is known as shear force at the section.

• Bending Moment: The algebraic sum of moments of all the forces acting to the one side of section is known as bending moment of the section.

• **Stress:** The force of resistance offered by a body against the deformation of the body is called as stress.

• Units: N/mm2 , N/m2 .Stress=force/area

Specifications

1. All RCC works should conform to IS: 456 2000.
2. Cement concrete is of grade M-40.
3. Maximum cement content should not exceed 450 kg/cum of concrete as per clause 8.2.4.2 of IS 456 2000 4.

Steel For Concrete Reinforcement:

• Fe 415 grade confirming to IS 1786-2008.
• MS grade -1 confirming to 432:1982 for mild steel.
• SEISMIC ZONES as per (IS 1893 (PART 1:2016))

Columns:

1. All RCC works should conform to IS: 456 2000.
2. Cement concrete is of grade M-40.
3. Maximum cement content should not exceed 450 kg/cum of concrete as per clause 8.2.4.2 of IS 456 2000.
4. **Steel For Concrete Reinforcement:**

• Fe 415 grade confirming to IS 1786-2008.
• MS grade -1 confirming to 432:1982 for mild steel.

Types of loads:

Dead load: This consists of the weight of walls, partitions, floors, roofs including the weights of all other permanent constructions in the building. The unit weights of building materials are given in code I.S:1911 code

• Live load: Live on floors shall comprise all the other than dead.

The minimum live on different floors for different uses shall be as given in table:

• Seismic loading: This is a fundamental concept in earthquake engineering that refers to the application of a seismic oscillation to a structure. It occurs at a structure's contact surfaces, either with the ground or with adjacent structures. Seismic loading is determined primarily by seismic hazard, geotechnical parameters of the site, and the natural frequency of the structure, among other factors. There are horizontal and vertical components to earthquake ground motion, but the horizontal component is the primary cause of bridge damage. As a result, only horizontal earthquake ground motion is taken into account in bridge design and analysis.

Staad pro

STAAD Pro is a general-purpose program for performing the analysis and design of a wide variety of types of structures. The basic three activities which are to be carried out to achieve that goal

a) Model generation

b) The calculations to obtain the analytical results

c) Result verification

Are all facilitated by tools contained in the program's graphical environment. This manual contains four sample tutorials which guide the user through those 3 activities.

• The first of those tutorials demonstrates these processes using a simple twodimensional steel portal frame. It is a good starting point for learning the program. If you are unfamiliar with STAAD Pro, you will greatly benefit by going through this tutorial first.

• For the second tutorial, we have chosen a reinforced concrete frame. We generate the model, perform the analysis, and design the concrete beams and columns. It contains extensive details on the various facilities available for visualization and verification of results.

• The modelling and analysis of a slab is demonstrated in the third tutorial. Slabs, and other surface entities like walls are modelled using plate elements. Large surface entities may have to be defined using several elements and this sometimes requires a tool called a mesh generator. This tutorial shows the simple techniques as well as the mesh generation method for generating the finite element model of the slab. It also explains the methods by which one can check the results for plate elements.

Modelling

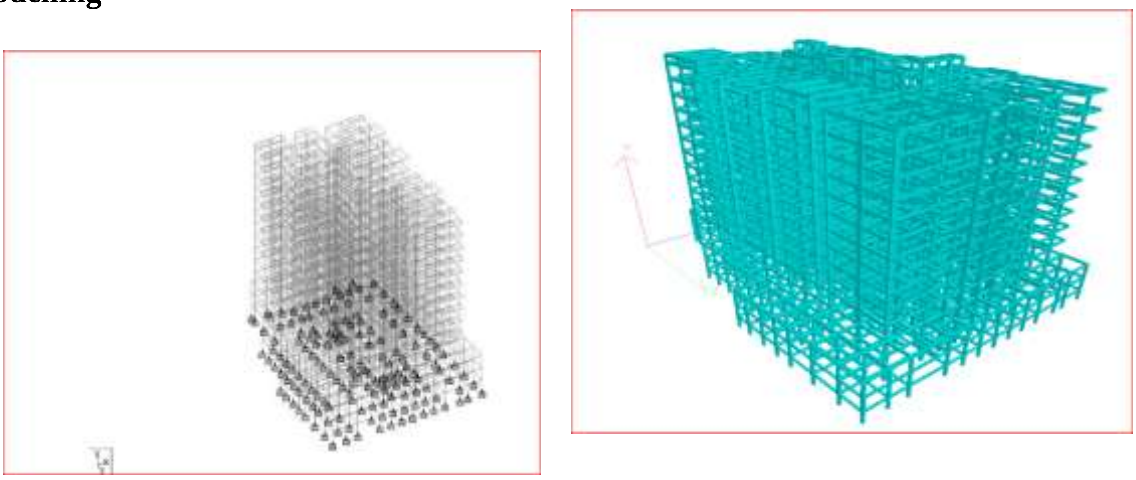
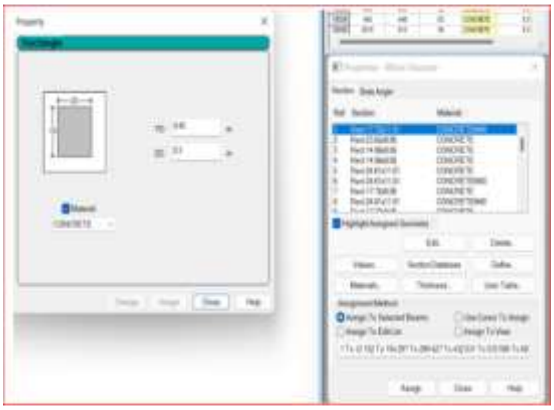


Fig3: Frame Modeling



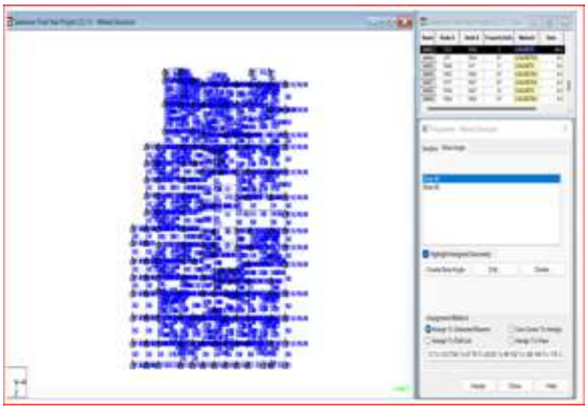
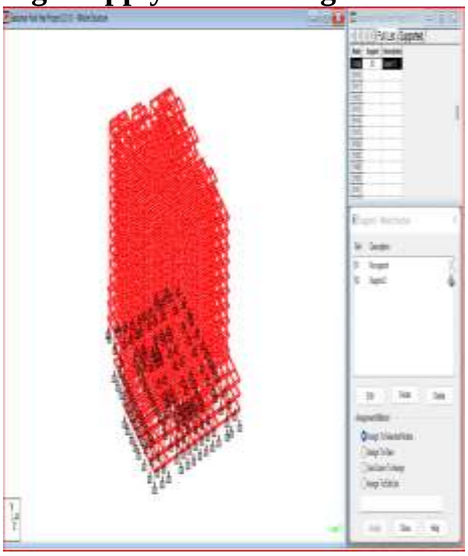


Fig 4: Assigning Supports:

Fig5: Apply for Loading



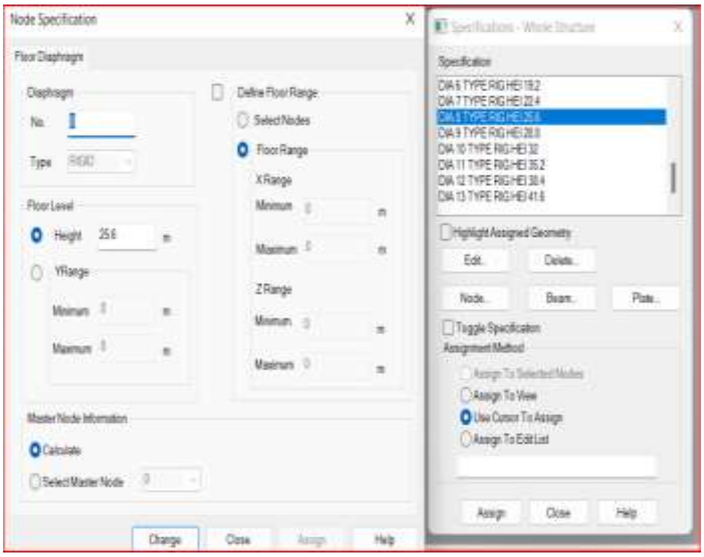


Fig6: Seismic Loads

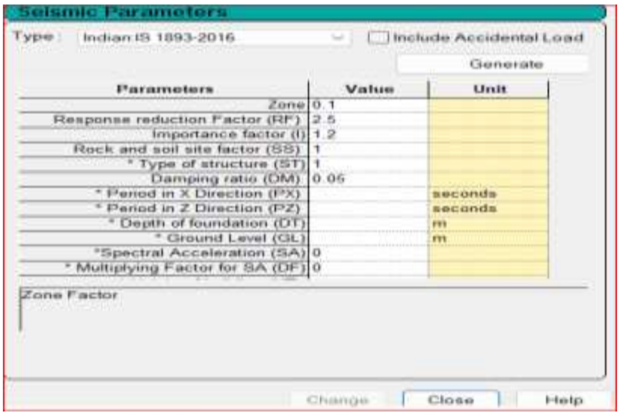


Fig 7 Seismic Parameters

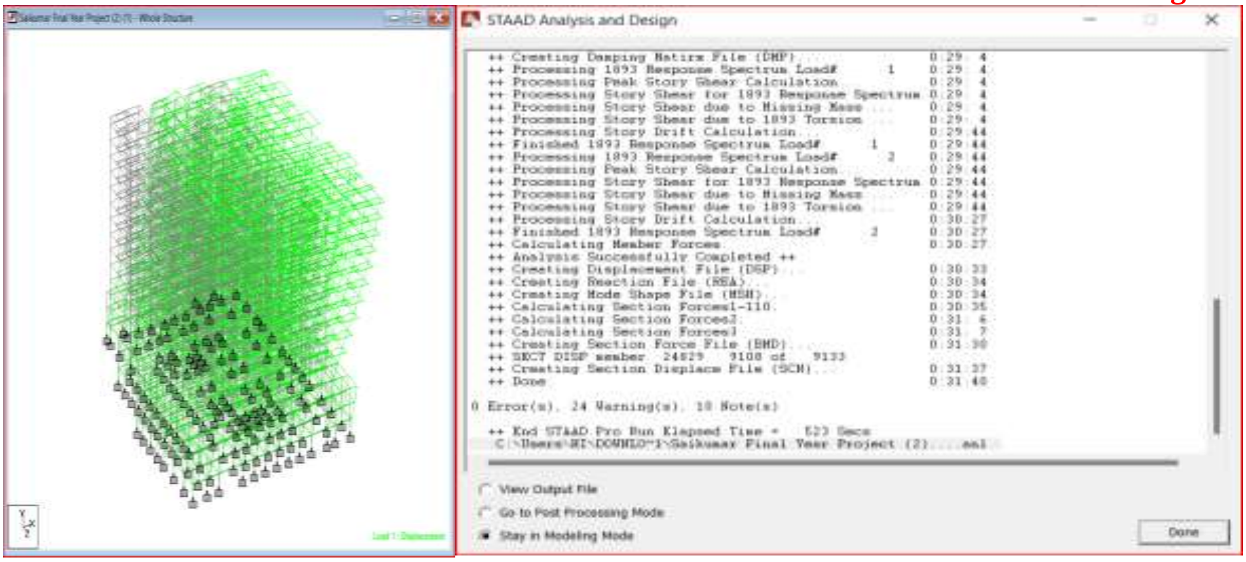


Fig8:Beam reactions

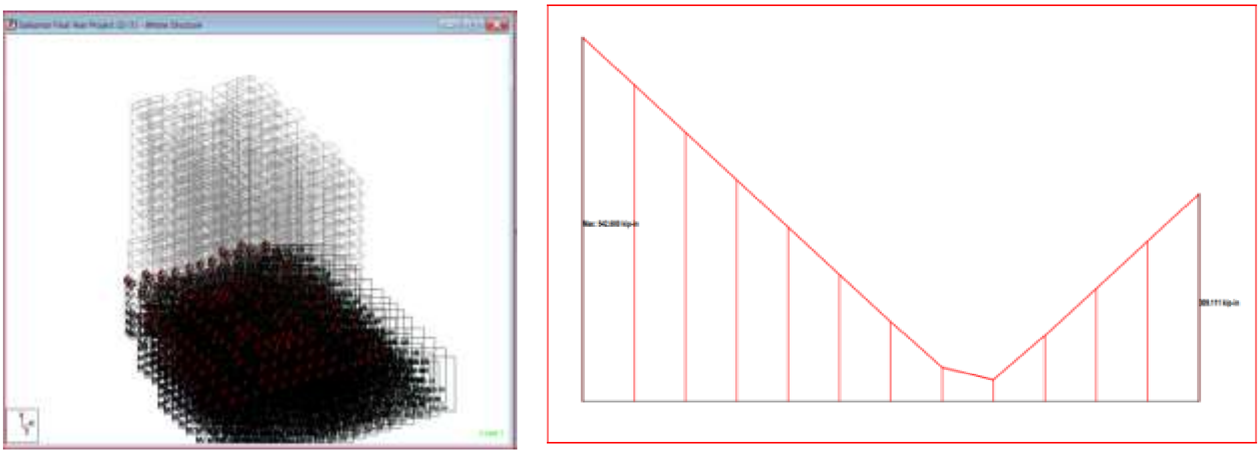


Fig 9:Shear force of beam

Results & Discussions

The aim of our project was bringing idea to plan, analysis and design of a multi-storeyed, earthquake resistant residential building. We were unsuccessful to fully complete the project in a successful and efficient manner by considering all the relevant features given. The design is completely depend on relevant Indian Standard Codes. The analysis and design has been done with the help of STAAD Pro and RCDC software and also the drawings have been made with the help of AutoCAD The aim of our project was bringing idea to plan, analysis and design of a multi-storeyed, earthquake resistant residential building. We were unsuccessful to fully complete the project in a successful and efficient manner by considering all the relevant features given. The design is completely depend on relevant Indian Standard Codes. The analysis and design has been done with the help of STAAD Pro and RCDC software and also the drawings have been made with the help of AutoCAD.

The goal of the project is to bring ideas to plan analysis and design of multistory earthquake resistant buildings, but we were unable to complete the project successfully and efficiently by taking into account all of the relevant features provided. The analysis and design were completed using STAAD Pro, and the drawings were completed using Auto CAD software. Building structural components are safe in shear and flexure.

Output File:

```
P R O B L E M   S T A T I S T I C S
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NUMBER OF JOINTS       5863  NUMBER OF MEMBERS    9133
NUMBER OF PLATES          0  NUMBER OF SOLIDS        0
NUMBER OF SURFACES        0  NUMBER OF SUPPORTS    184

Using 64-bit analysis engine.

SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

ORIGINAL/FINAL BAND-WIDTH= 4633/ 253/ 15823 DOF
TOTAL     PRIMARY LOAD CASES =     4, TOTAL DEGREES OF FREEDOM =   15867
TOTAL LOAD COMBINATION  CASES =    22  SO FAR.
SIZE OF STIFFNESS MATRIX =  251064 DOUBLE  KILO-WORDS
REQRD/AVAIL. DISK SPACE  =   3822.0/   3671.9 MB

**NOTE: MASSES DEFINED UNDER LOAD#      1 WILL FORM
       THE FINAL MASS MATRIX FOR DYNAMIC ANALYSIS.

EIGEN METHOD   : SUBSPACE
-------------------------
NUMBER OF MODES REQUESTED              =    20
NUMBER OF EXISTING MASSES IN THE MODEL =  5688
NUMBER OF MODES THAT WILL BE USED      =    20

*** EIGENSOLUTION: SUBSPACE METHOD ***
STAAD SPACE                                    -- PAGE NO.  133
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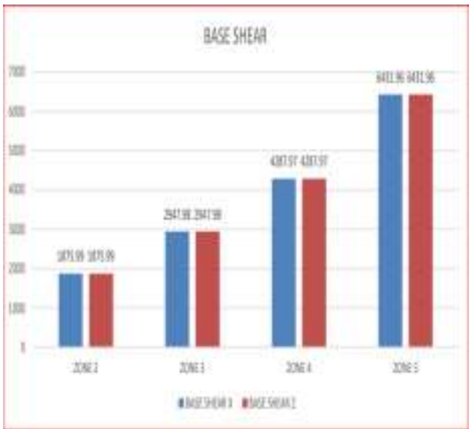
Time Period:

STAAD SPACE -- PAGE NO. 133

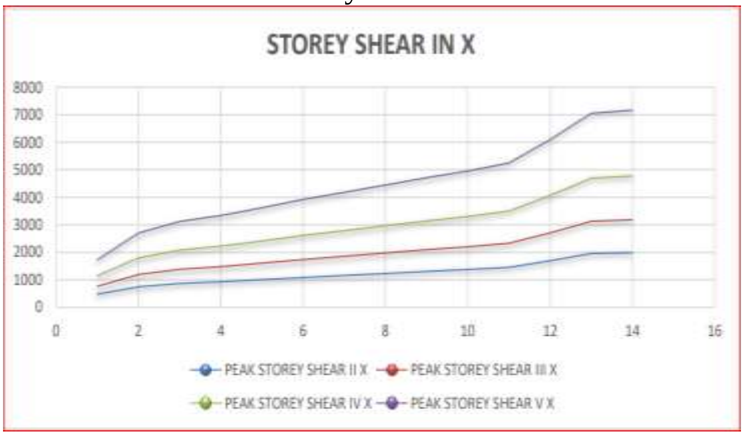
CALCULATED FREQUENCIES FOR LOAD CASE 1

MODE	FREQUENCY(CYCLES/SEC)	PERIOD(SEC)	ACCURACY
1	0.287	3.48607	1.367E-16
2	0.308	3.25130	0.000E+00
3	0.315	3.17053	2.262E-16
4	0.844	1.18445	3.788E-16
5	0.928	1.07803	6.275E-16
6	0.952	1.05003	3.969E-16
7	1.130	0.88499	1.410E-15
8	1.133	0.88279	1.964E-15
9	1.133	0.88242	4.905E-15
10	1.137	0.87942	4.176E-16
11	1.140	0.87714	3.323E-15
12	1.143	0.87512	2.895E-15
13	1.144	0.87429	1.651E-15
14	1.377	0.72597	1.707E-15
15	1.397	0.71569	5.531E-16
16	1.550	0.64503	1.498E-16
17	1.573	0.63589	1.456E-15
18	1.994	0.50157	1.592E-10
19	2.150	0.46502	1.836E-08
20	2.188	0.45703	1.647E-07

Base shear

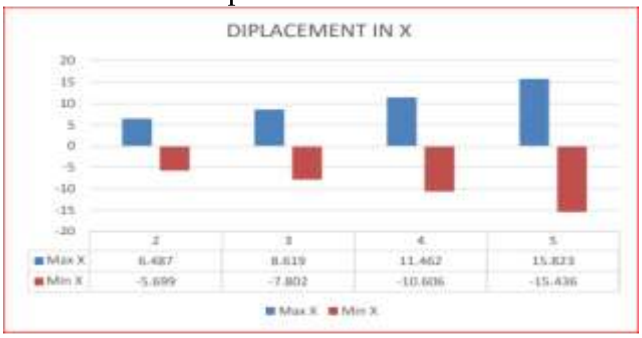


Storey Shear in X:



Storey Shear in Z:

Displacement



Conclusion

➢ Base Shear:

• From zone2 to zone3 the base shear is increased 57.14%
• From zone3 to zone4 the base shear is increased 45.45%
• From zone4 to zone5 the base shear is increased 49.95%

➢ Storey shear:

• In X direction:
• From zone2 to zone3 the Storey shear is increased 60% (at base)
• From zone3 to zone4 the Storey shear is increased 49.99% (at base)
• From zone4 to zone5 the Storey shear is increased 49.9% (at base)
• In Z direction: • From zone2 to zone3 the base shear is increased 59.8% (at base)
• From zone3 to zone4 the base shear is increased 50% (at base)
• From zone4 to zone5 the base shear is increased 50% (at base)

➢ Diplacement:

• In X direction:

• From zone2 to zone3 the Max Displacement is increased 32.86%
• From zone3 to zone4 the Max Displacement is increased 32.98 %
• From zone4 to zone5 the Max Displacement is increased 38.04 %
• In Y direction:
• From zone2 to zone3 the Max Displacement is increased 49.461%
• From zone3 to zone4 the Max Displacement is increased 49.9%
• From zone4 to zone5 the Max Displacement is increased 50.01 %
• The G+10 residential building has been analyzed using STADD. Pro. Seismic forces have been considered and the structure is designed as an earthquake resistant structure.

To conclude, STADD. Pro is versatile software having the ability to determine the Base shear, Storey Shear, Storey Drift,, Displacement etc. It experiences static as well as dynamic analysis of the structure and gives accurate results which are required..

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