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DESIGN AND ANALYSIS OF MULTI STORIED BUILDING WITH ISOLATORS

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ABSTRACT

Every civil engineering construction, whether it is a building, transportation infrastructure, a dam, earth retaining structures, or a tunnel, must be built on the ground. Previous earthquakes resulted in the dramatic collapse of high-rise reinforced concrete structures Buildings with closely spaced structures in a densely inhabited region. Because of the increasing Because of urbanization and land constraint, the need for high-rise constructions has increased created in earthquake-prone locations with less-than-ideal geotechnical constraints regions. The interaction of the three systems affects the deformation of a structure during earthquake excitation: the structure, foundation, and underlying soil and encircling the foundation. The conventional method of seismic analysis of structures Assuming the structure is stationary at its base, ignoring the influence of soil-structure interaction. The primary goal of this research is to create a three-dimensional reinforced concrete moment resistant framed structure that incorporates soil-structure interaction. The study contains a numerical model of a G+10 high-rise RC structure created with a numerical tool. Structural Analysis Program 2000 (SAP2000) and perform response spectrum analysis in accordance with IS: Time history study of four big earthquakes from 1893 to 2016.

I. INTRODUCTION

Ground structure interaction (SSI) refers to the interaction between soil (ground) and a structure erected on it. It is essentially a reciprocal stress exchange, with both the kind of ground and the type of structure impacting the movement of the ground-structure system. This is particularly true in seismically active areas. The vast majority of civil engineers Constructions have some type of structural element that is directly connected to the ground. Seismic During earthquakes, waves spread from the bedrock through the soil layers, causing damage. On the surface, there are buildings. When such external factors act on these systems, neither the system nor the Neither structural nor ground displacements are independent of one another. This is the case. This is known as soil-structure interaction (SSI). Different soil and structural combinations can either enhance or lessen movement and the resulting damage. Damage would be greater to a structure built on stiff ground rather than flexible ground. Foundation is a second interaction effect connected to soil mechanical properties. Sinking is accelerated by a seismic event. This is known as soil liquefaction Traditional structural design methods disregard SSI effects. For light constructions on moderately flat terrain SSI is neglected in stiff soil, such as low-rise structures and simple rigid retaining walls. However, For high-rise buildings or massive structures resting on relatively soft ground, the SSI becomes relevant.

II. METHODOLOGY

- 3D model of the building : The first step in utilizing SAP2000 software is to generate a 3D model of the building using the modeling capabilities in the program. The model should incorporate all of the building's structural features, such as columns, beams, slabs, and walls as well as foundations.
- Material properties : Material qualities of structural components must be specified. This involves specifying the qualities of the concrete, steel, and other materials that will be utilized in the building's construction.
- Loading Conditions : The next stage is to determine the loading conditions that will be applied to the building. This involves specifying the dead loads, live loads, wind loads, earthquake loads, and any other loads that may be applicable to the design.
- Analysis of structure : The structural analysis may be performed using the SAP2000 program after the model has been defined and the loading conditions have been established.
- Evaluating the results : Once the structural analysis is complete, the results can be evaluated to identify any areas of concern or potential issues that need to be addressed.
- Comparitive analysis : This enables designers to assess the performance of several design alternatives and

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choose the one that best fulfills the project's goals and objectives.

- Design Finalization : The program can produce comprehensive drawings, specifications, and other papers for usage during the building phase.

❖ **SOFTWARE USED**

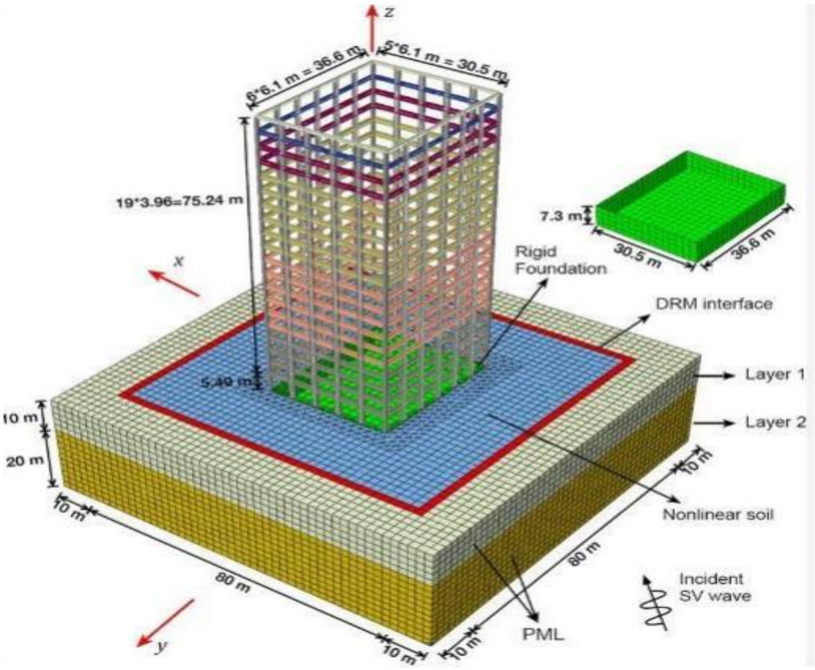
SAP2000 :

SAP2000 is a stand-alone finite-element structural tool for civil structure analysis and design. It provides an easy yet powerful user interface with several tools to help in the speedy and precise production of models, as well as complex modeling capabilities. Analytical procedures are required to complete the most difficult undertakings.

Because SAP2000 is an object-based system, the models are developed with components that represent the real world. A beam with several members framing it is formed as a single object, much as in the real world, and the software handles the internals. To ensure connectivity with the other members, meshing is essential. Analysis and results .The design is offered for the whole object rather than for each component portion, which gives information that is both simpler to grasp and more in keeping with the real structure.

SAP2000 modeling of a high-rise building :

The Indian standard IS 875 (Part 3) designated buildings based on height as low-rise if their height was less than 20m. A mid-rise building has a height of 20m to 50m, whereas a high-rise structure has a height more than or equal to 50m. From a structural standpoint, it may be referred to as a structure whose height can be modified. By lateral loads caused by wind and seismic activity to the extent that those loads would play an important part in the design process. A 10-story concrete moment resistant structure. In the current investigation, a building frame of 75m height and 25m width was used. 5 horizontal spans (along the x-axis) and 30m broad (6 longitudinal spans) (along the y-axis) supported by several kinds.



III. MODELING

MODEL DETAILS :

NUMBER OF STORIES	G+10
FLOOR TO FLOOR HEIGHT	3.2
SIZE OF BEAM	300X300
SIZE OF COLOUMN	600X600
THICHNESS OF SLAB	125mm

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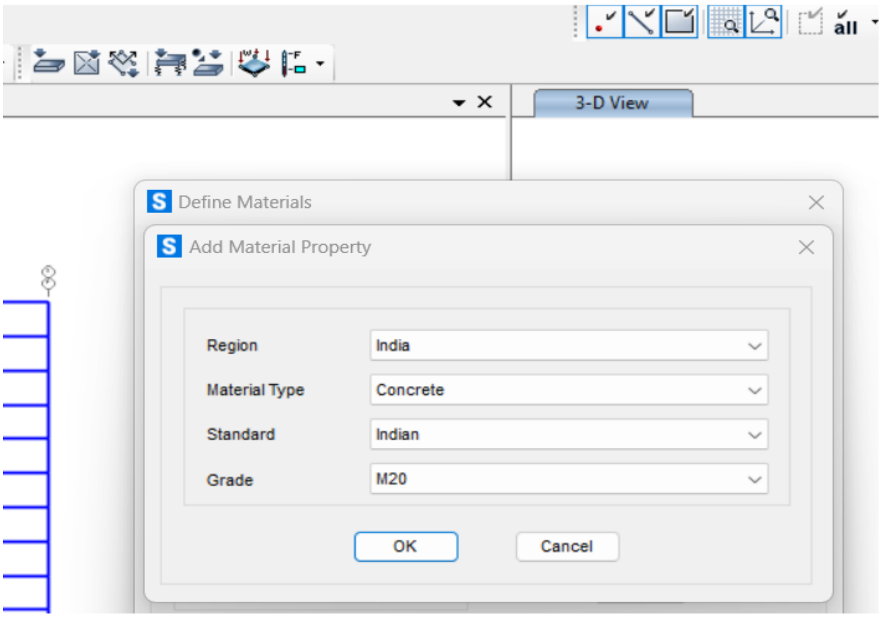
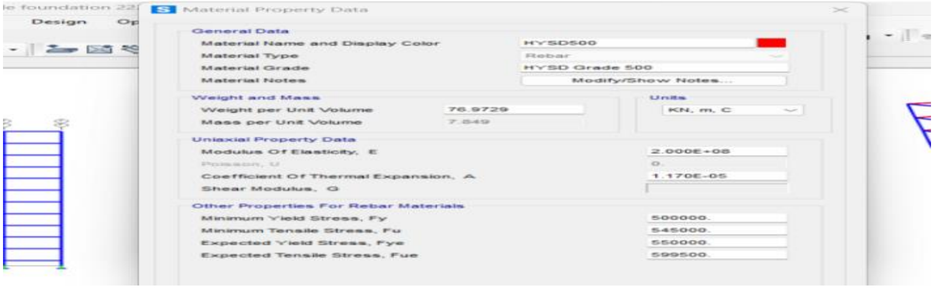
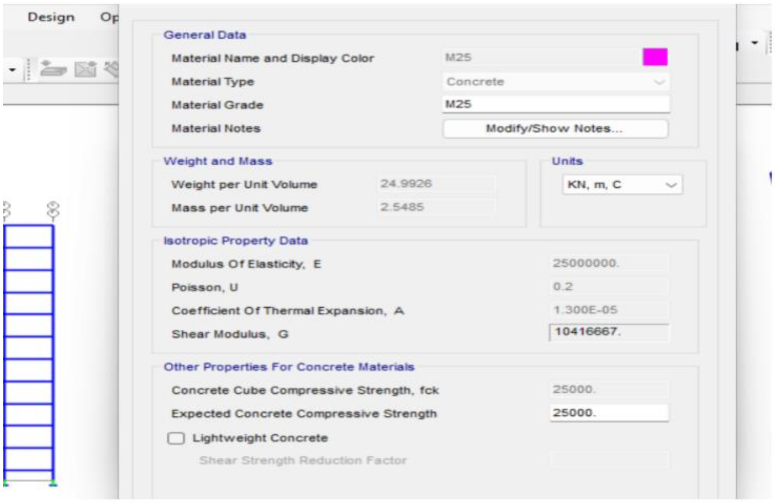
GEADE OF CONCRETE(fck) COLOUMNS BEAMS	 M20 M25
GRADE OF REBAR(fy)	Fe 500
LIVE LOAD	2KN/m
FLOOR FINISH	1.5 KN/m
SESMIC ZONE	ZONE II
REDUCTION FACTOR	3

SUB-STRUCTURE DESCRIPTION:

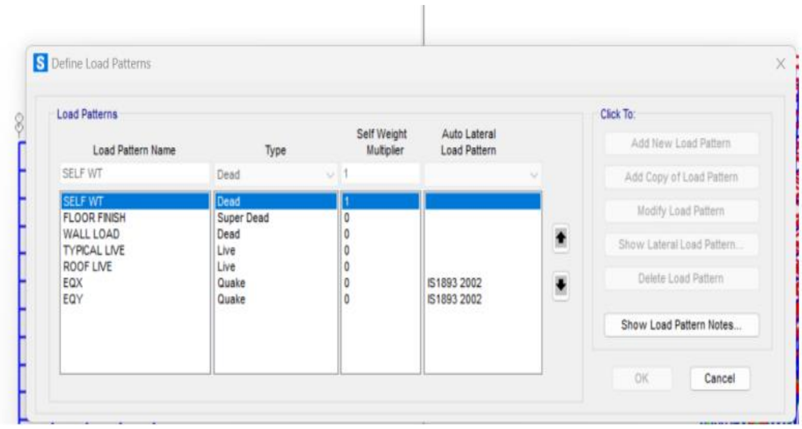


MATERIAL PROPERTIES FOR CONCRETE AND REBAR:

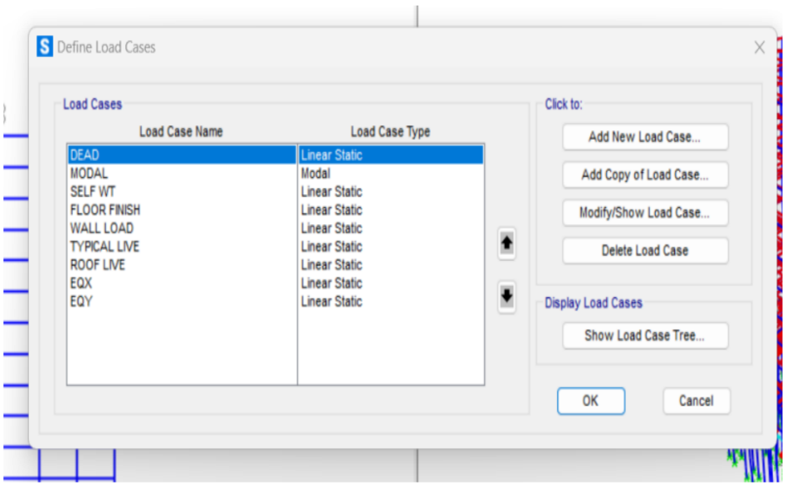




DEFINING LOAD PATTERNS :

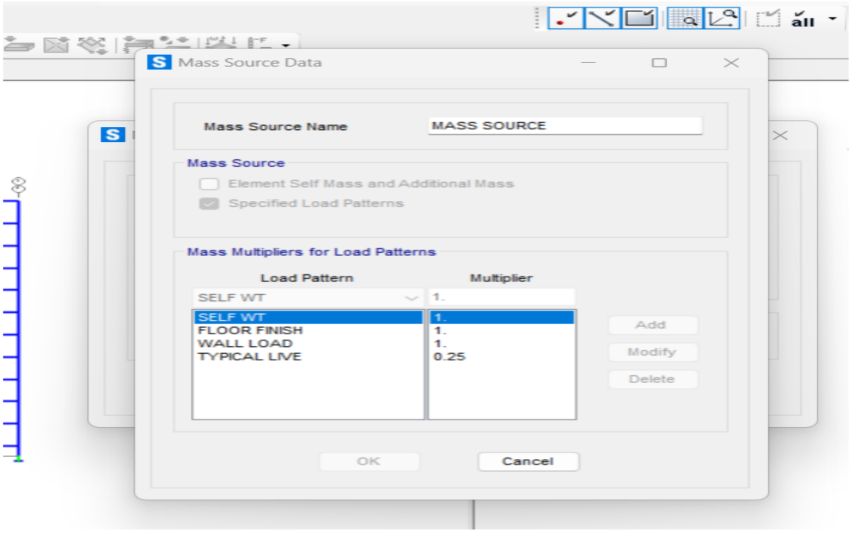


DEFINING LOAD CASES :

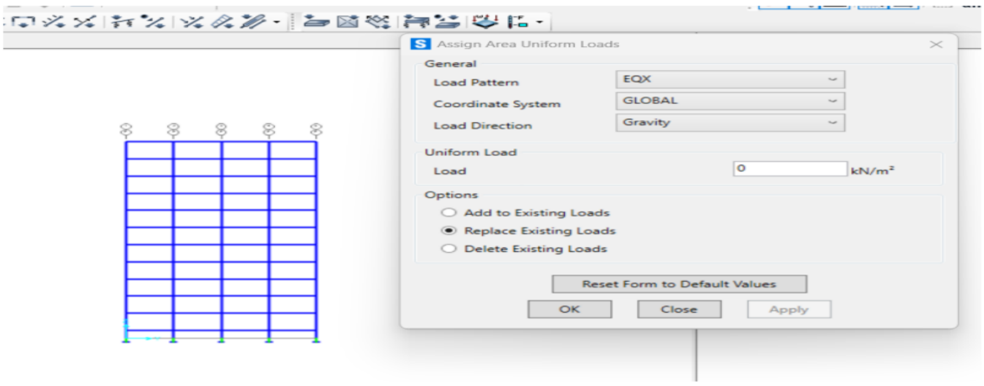


DEFINING MASS SOURCE:

According to the code, a seismic weight is used for seismic analysis. demands the effective seismic weight, which includes dead load and other load; in this case, other load is LL reduction; hence, the value of reduction factor f for LL is found.

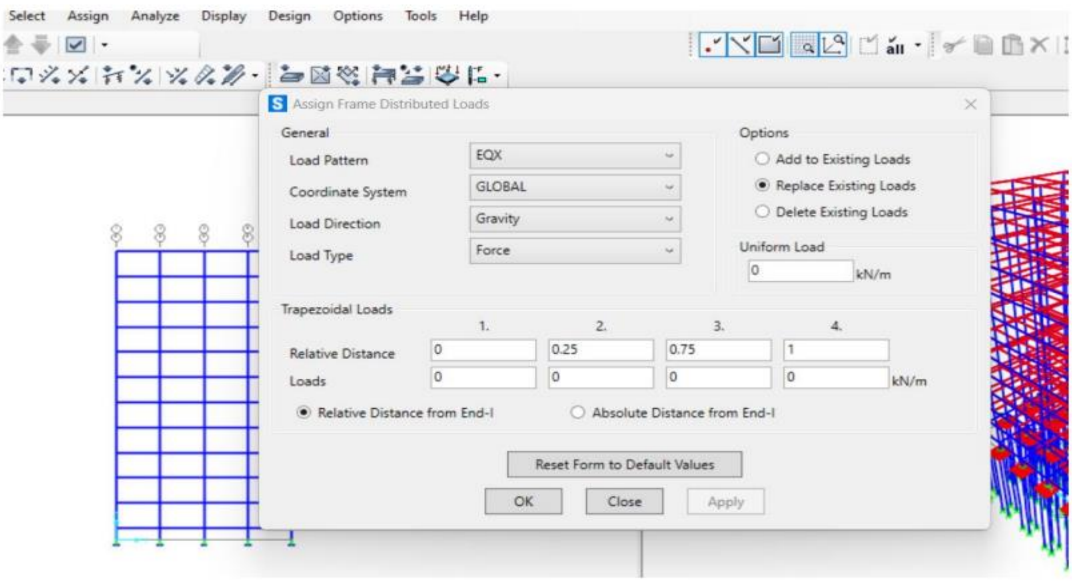


ASSINING AREA UNIFORM (SHELL) LOADS:



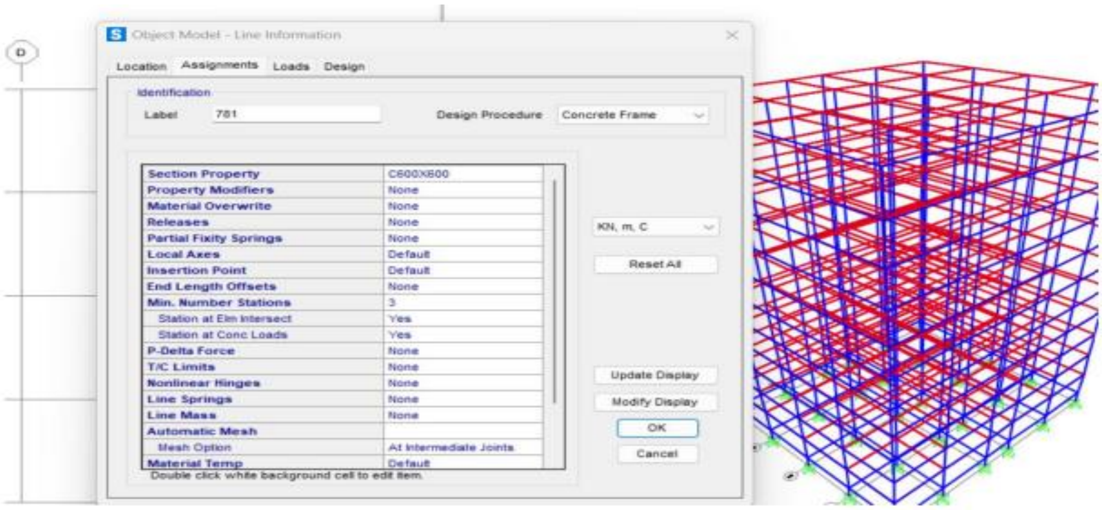
Area loads - Apply shell loads in the same way by choosing the wall and proceeding to Assign > Shell loads > Uniform or Non-Uniform loads.

ASSINING FRAME DISTRIBUTED LOADS :



To access the Area Uniform Loads to Frames form, go to the Assign menu > Area Loads > Uniform to Frame (Shell) command. Load the Pattern Name drop-down menu.

OBJECT MODEL - LINE INFORMATION :



APPLIED WALL LOAD TO THE STRUCTURE :

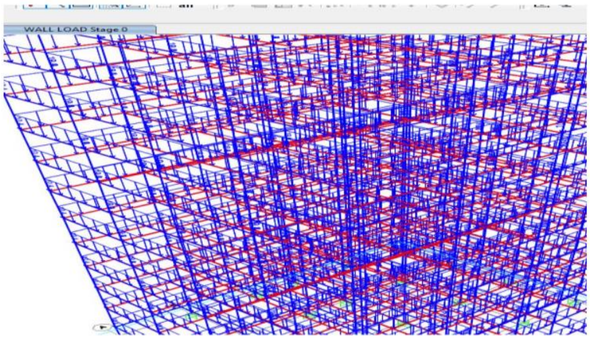
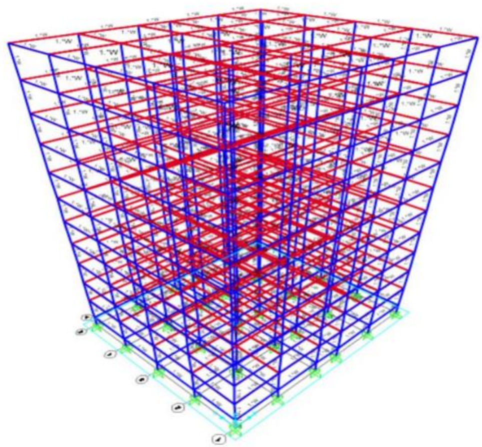


IMAGE OF THE SUPER STRUCTURE :



Foundation modelling :

Shallow or deep foundations, or a mix of the two, are the most common types of foundations. Shallow foundation includes raft, spread, and isolated footing. Deep foundations are defined as pile foundations. Pile foundations are a type of foundation. Friction and end bearing vertical support were used to construct this structure. Structures supported by piles .The foundation is more resistant to uplift pressures. Deep foundations are more rigid in comparison to shallow foundations. Because of several intrinsic characteristics such as the mix of shallow and deep foundations, as well as strength and stiffness, is not used.

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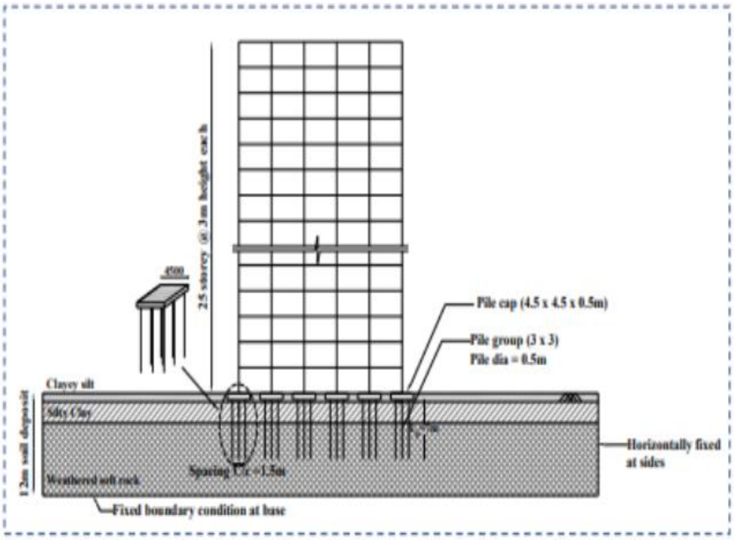
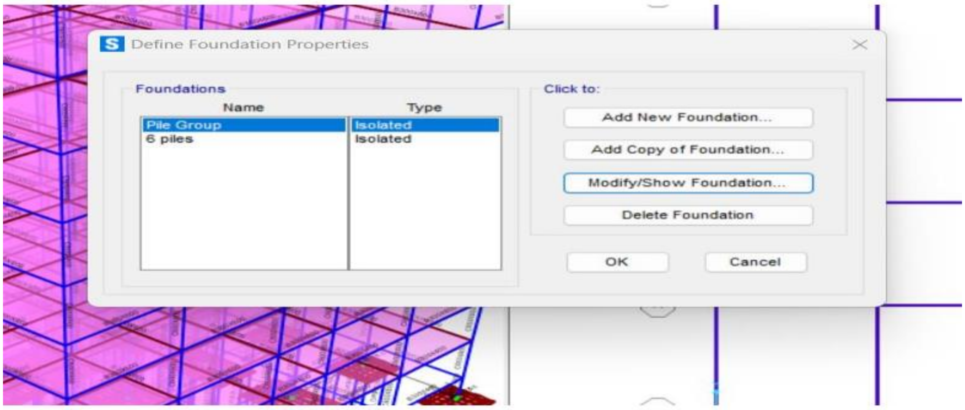


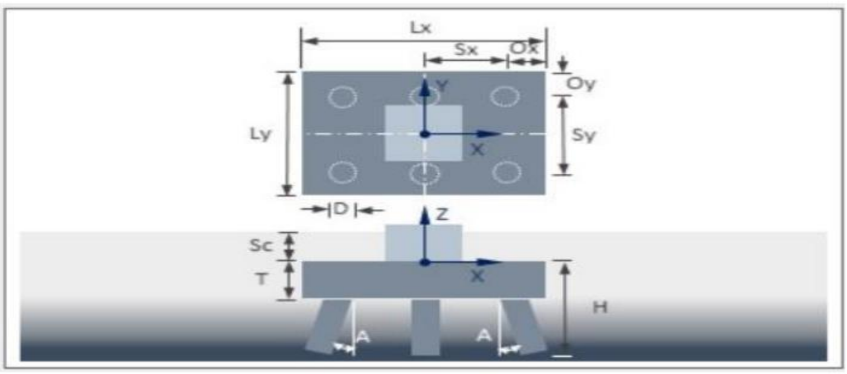
Sectional properties of pile foundation

DEFINING THE FOUNDATION PROPERTIES :



Is a thin column or long cylinder composed of concrete or steel that is used to support the structure and transfer the load at the necessary depth. The pile size is 750mm diameter and has a capacity of 120 Tons (1200KN). The distance between two piles is three times the pile's diameter. The number of piles is determined by the design response of each footing. This data pile cap is built with a depth of 1.2 metre and a 150mm clear cover.

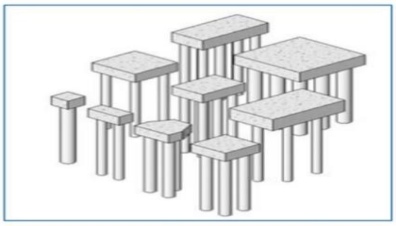
DESIGN OF PILE FOUNDATION:

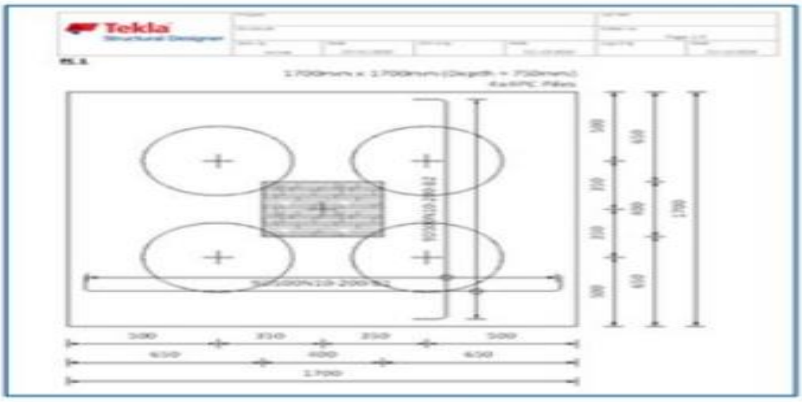


Pile foundations are a type of deep foundation that consists of a thin column or long cylinder made of materials such as concrete or steel that supports the structure and transmits the load at the required depth via end bearing or skin friction. Piles are pushed deep into the soil to ensure the stability of the buildings built above them. Heavy loads can be transmitted to more stable subsurface elements such as rock or hard soil using piles.

The piles are securely anchored in the earth and serve as structural support. Because of their entrenched character, pile foundations are more resistant to scour and erosion.

Parametric definitions:





KEY ASPECTS OF DESIGN ARE :

Pile caps can be represented by 1 to 9 pile arrangements.

There are auto-design choices for cap depth, pile number, and reinforcement.

The following checks are carried out, with full design information provided for each:

- Pile capacity check
- Pile cap bending check
- Pile Cap shear capacity check
- Column and pile punching shear check
- Pile pair punching check
- Pile one-way shear check.

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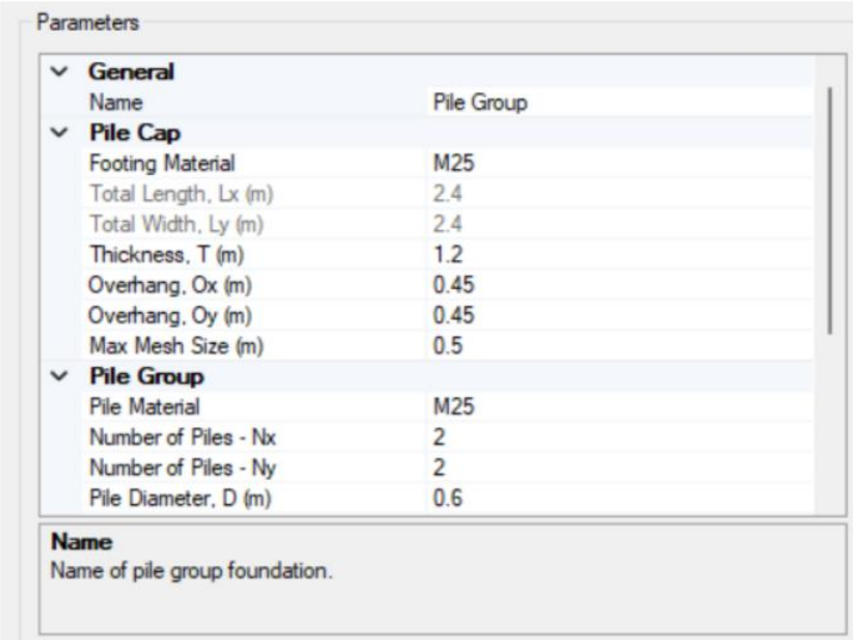
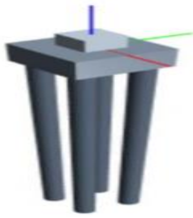
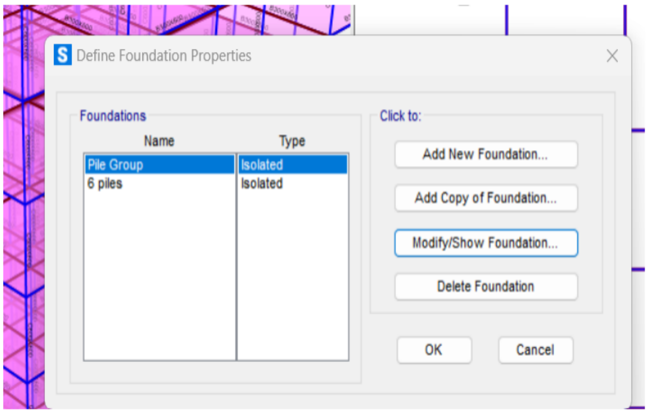
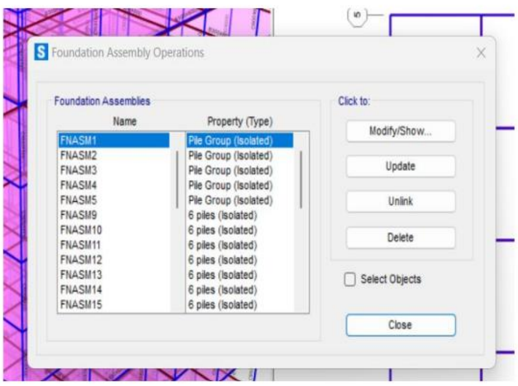


ADDING OF PILE :





FOUNDATION ASSEMBLY OPERATIONS :



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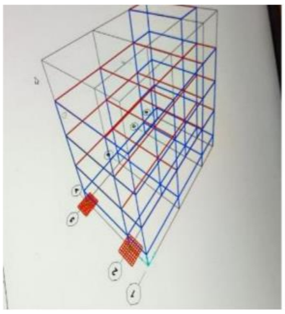
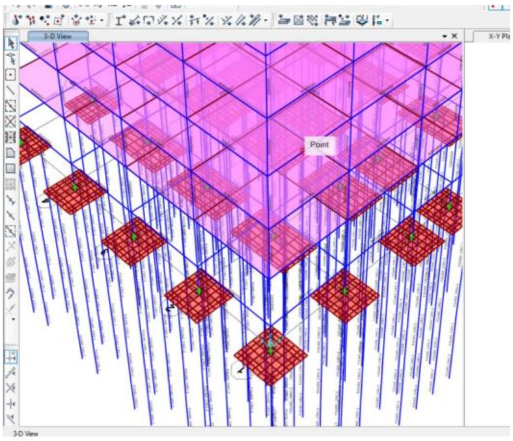
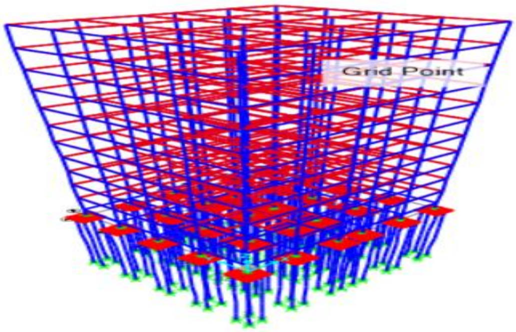
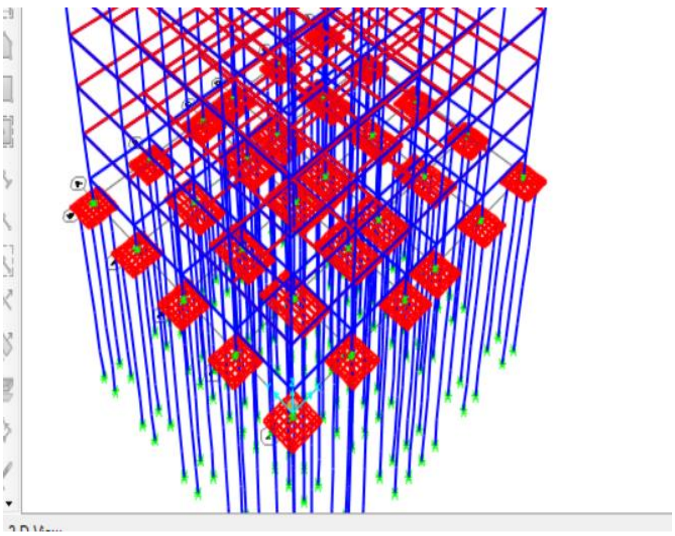
ADDING PILE @ EVERY POINT OF THE COLOUMN :



Adding the piles to superstructure:







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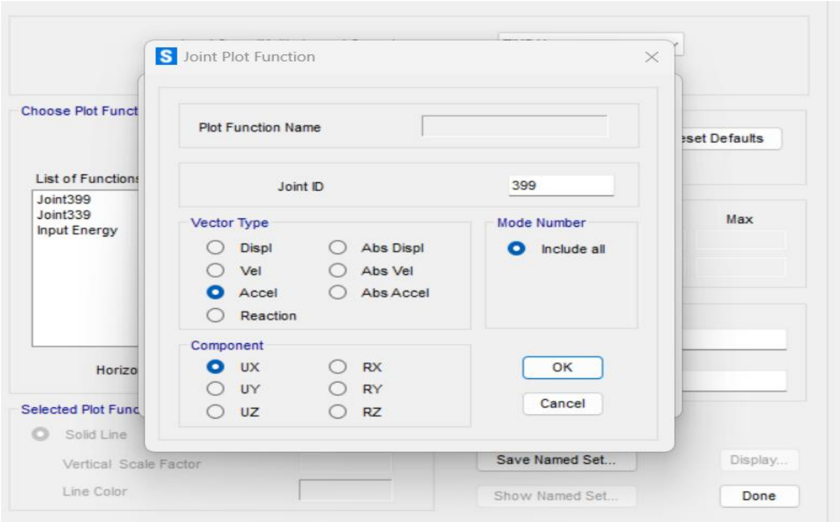
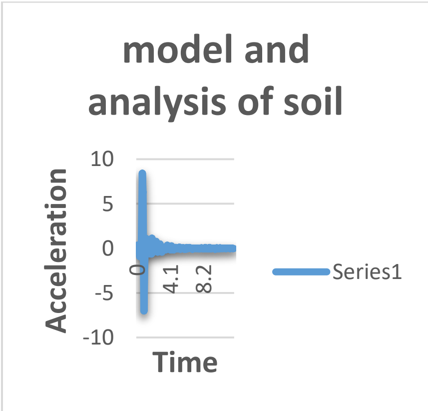
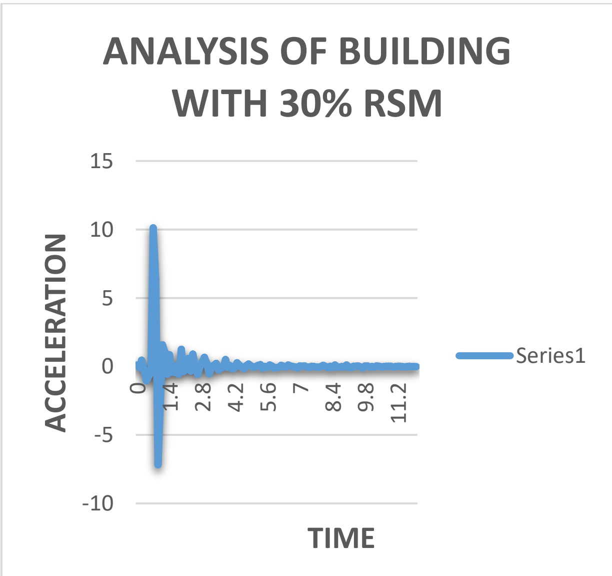
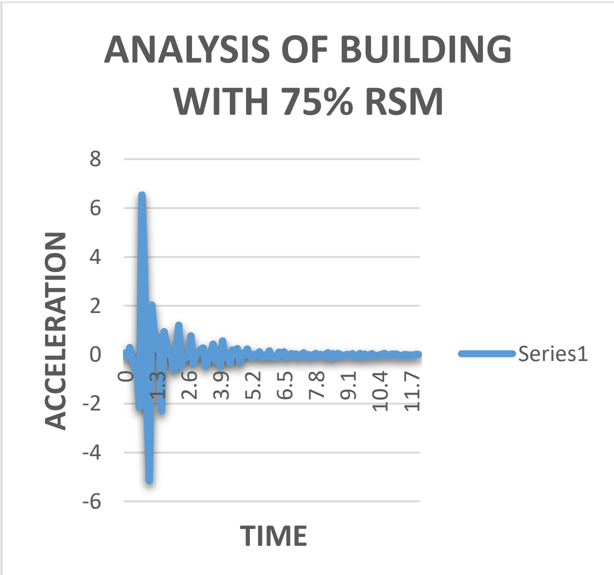
Defining the Function :



When the input is in the form of a defined time history of ground motion, Time History Analysis of Structures is performed. Direct Integration Methods or the Fourier Transformation Technique are used to accomplish Time History Analysis.



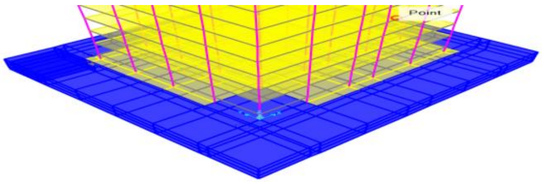


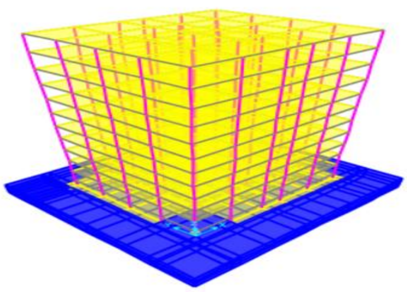


STANDARD CASE :

Gives a schematic illustration of the usual case for evaluating the proposed earthquake protection system. A G+10 story building is used as an example since it is one of the most common forms of constructions in rural regions.

It is supported by discrete footings and surrounded by a layer of soil mixed with a specific material. Rubber-soil mixture (RSM) percentage of thickness B (where B is the breadth of the footing) and B in breadth (where B is the footing's width). The earth is always there in every environment.





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Properties of RSM and Sub-soil :

Numerous laboratory studies have been carried out in order to establish the engineering properties of RSM and subsoil. The densities of RSM 30%, 50%, 50%+R, 75% (percent rubber tyre crumbs by volume), and RSM 75%+R are determined by IISc Bangalore laboratory measurements (unpublished data). Bangalore

The city's site condition has been considered, and laboratory tests have been conducted. utilized to determine the subsoil characteristics. The sub-characteristics are soils to obtain a from a more practical standpoint, the subsurface is used as the c-material here, and the RSM material is used. Isotropic treatment is used.

Input parameters for foundation soil:

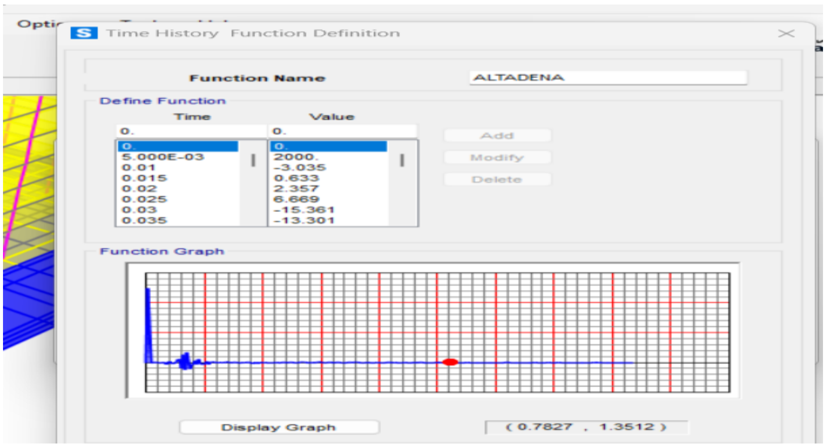
Soil type	Unit weight (kN/m3)	Cohesion, C (kN/m2)	Angle of internal frictionØ (Degrees)	Poisson's ratio
clay	13.92	50	19	0.4
Hard Rock	27	0	40	0.3

Time steps :

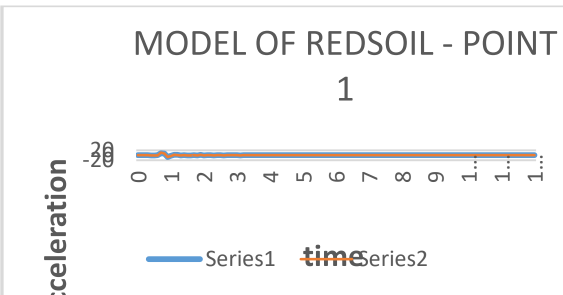
Sufficient output time steps are required for proper depiction of the periodic solution in either modal or direct-integration time-history analysis. A time increment of one-tenth of the shortest time period of interest should capture response correctly.

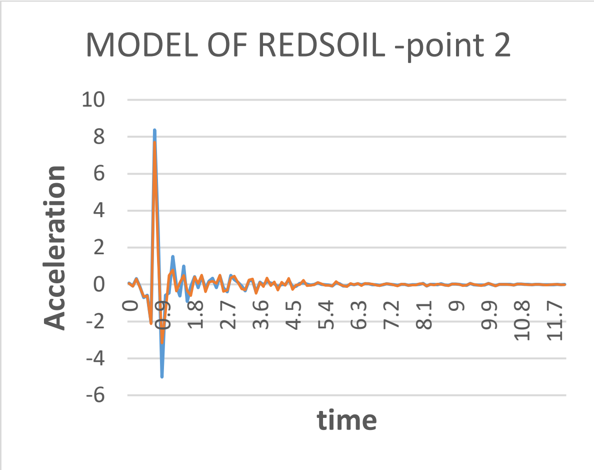
Moving-load analysis :

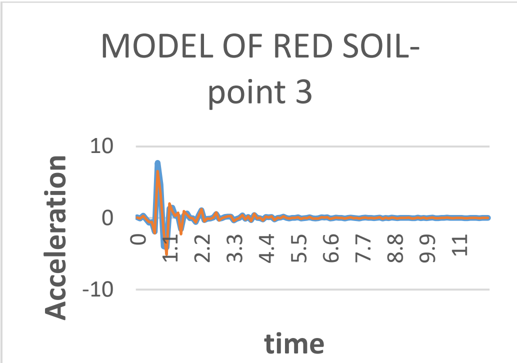
A step-by-step moving-load analysis can help in bridge analysis and design. Separate load patterns are created at distinct sites along the bridge by automated step-by-step vehicle loading, increasing one load pattern while lowering the next. At any one time, one pattern is entirely applied, or two patterns are interpolated. Otherwise, turning one pattern on, then abruptly turning it off while turning on the next pattern provides an impulse-type load (similar to hammer impact), which will excite higher frequencies and impair acceleration response.

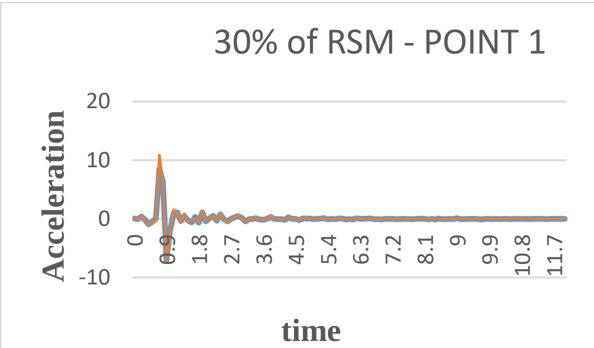


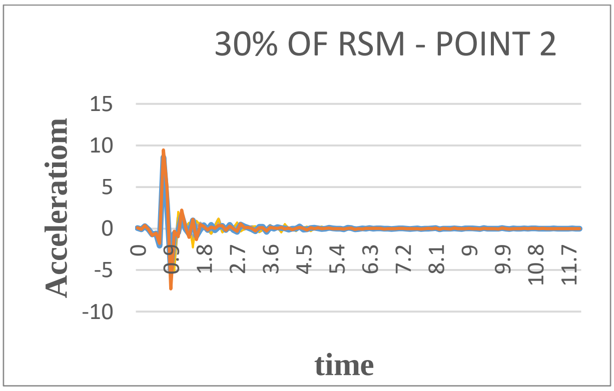
IV. RESULTS AND READINGS




MODEL OF REDSOIL -point 2
Acceleration
time
10
8
6
4
2
0
-2
-4
-6
0
0.9
1.8
2.7
3.6
4.5
5.4
6.3
7.2
8.1
9
9.9
10.8
11.7


MODEL OF RED SOIL-
point 3
Acceleration
time
10
0
-10
0
1.1
2.2
3.3
4.4
5.5
6.6
7.7
8.8
9.9
11


30% of RSM - POINT 1
Acceleration
time
20
10
0
-10
0
0.9
1.8
2.7
3.6
4.5
5.4
6.3
7.2
8.1
9
9.9
10.8
11.7


30% OF RSM - POINT 2
Acceleratiom
time
15
10
5
0
-5
-10
0
0.9
1.8
2.7
3.6
4.5
5.4
6.3
7.2
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9.9
10.8
11.7

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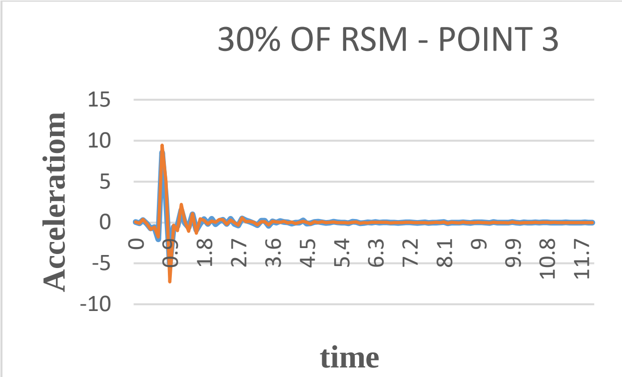

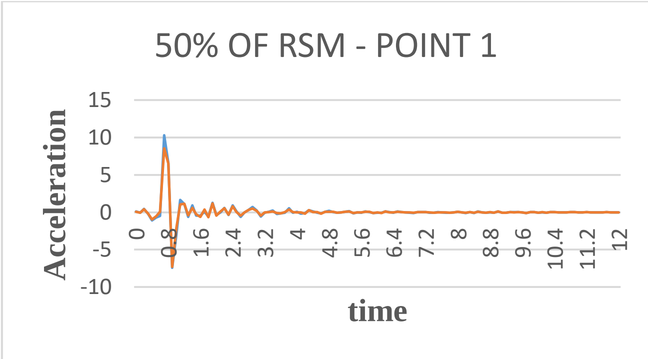

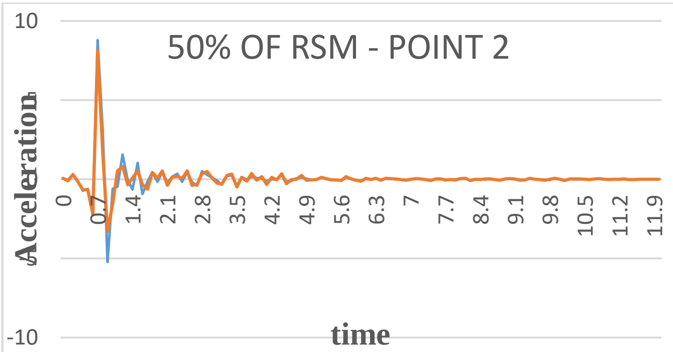

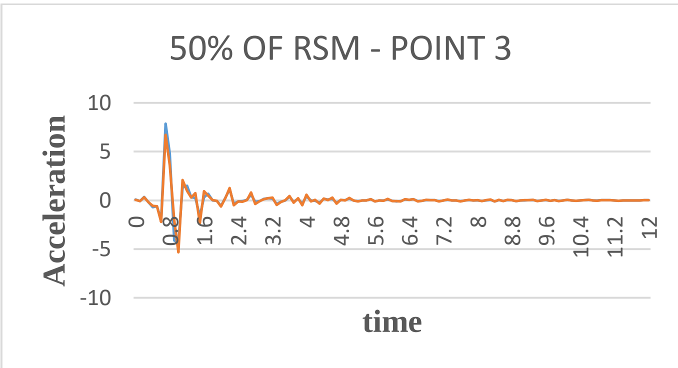

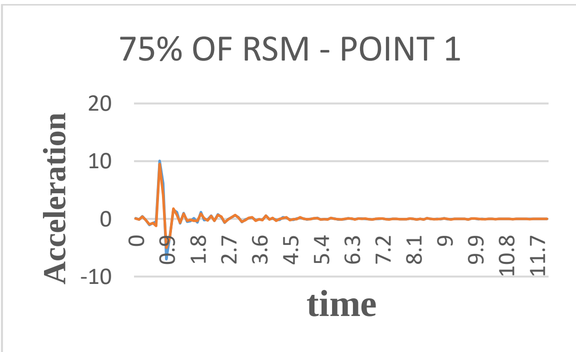

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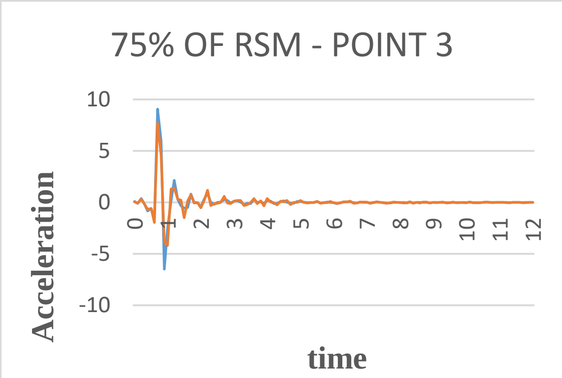
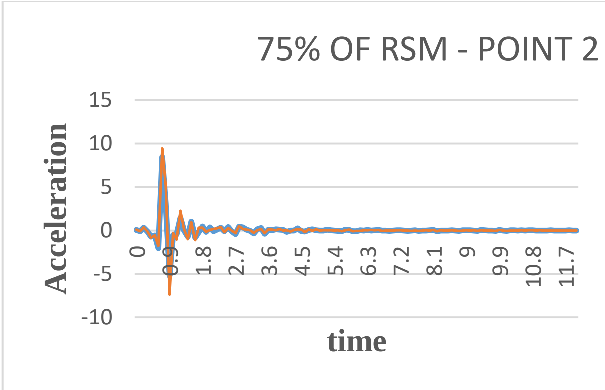
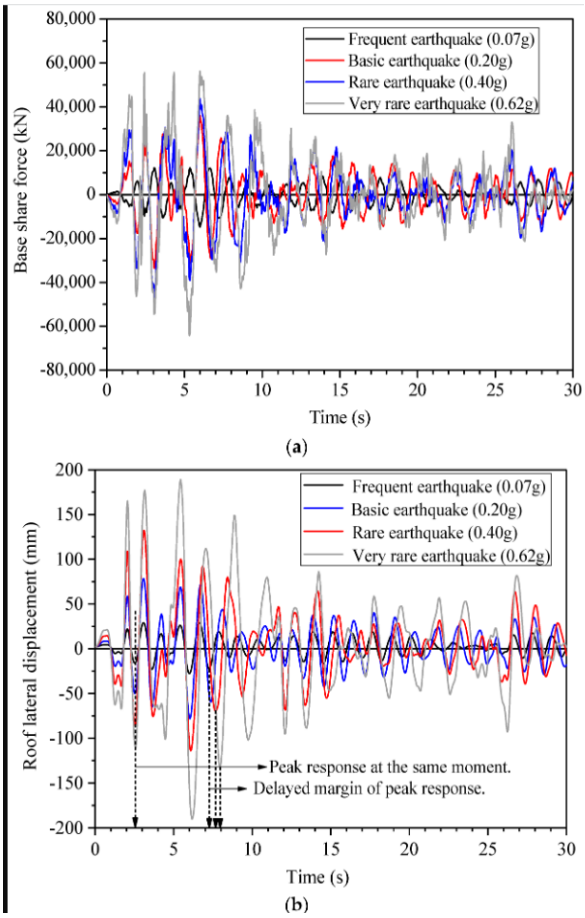
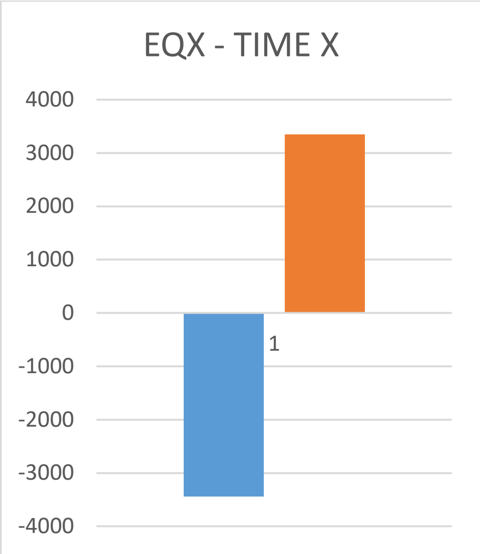


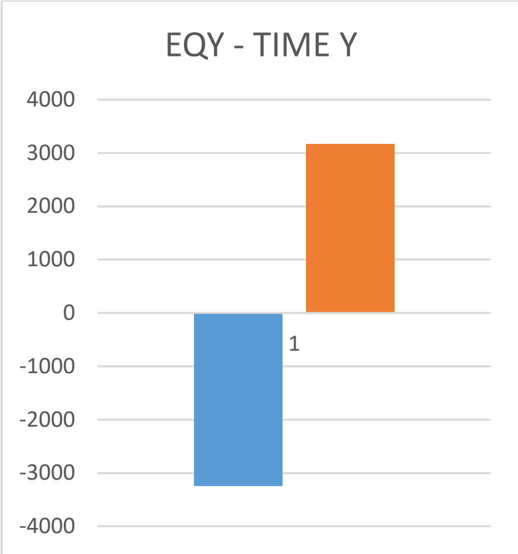


Base shear:

Base shear is the total of the planned lateral pressures at the base taken into account for the entire story above. A building's base shear is affected by both spectral acceleration (Sa/g) and mass. The shear force created in a structure during seismic stimulation is shown by the base shear. When SSI is used When base shear is considered, a reduction in base shear is frequently observed in medium to stiff subsoils. In contrast, base shear tends to grow in soft soil. The structural for response spectrum analysis, consider the response in relation to the base shear. It is determined using seismic zone, soil material, and building code lateral force equations (IBC/UBC notations are utilized in mathematical calculations).







V. CONCLUSION

Summary :

The feasibility and resilience of a novel seismic isolation technology based on rubber-soil mixtures (RSM), initially described by Tsang, are evaluated using numerical simulations in this work . The study's goal has been established as a 10-story skyscraper.

At the outset, novel earthquake protection strategies involving the usage of external devices were described. Seismic isolation has been demonstrated to be particularly useful in safeguarding low- to medium-rise structures against earthquakes. Rubber has been widely employed as a fundamental component of seismic protection due to earthquake damage. Isolation systems. A review of previous studies on the effectiveness of the novel approach of earthquake protection. It is obvious that the unique seismic isolation method. The strategy might greatly reduce the level of building reaction.

The pile foundation-supported structure had less inter-storey drift than the raft foundation-supported structure. The maximum inter-storey drift of raft foundation increased by 21.5% as a result of the 2001 Bhuj earthquake. The building is supported by a pile foundation. Similarly, the Northridge Act of 1994

Following an earthquake, the maximum inter-storey drift measured for pile foundations is reduced approximately 54.20% when compared to the raft-supported construction. When SSI was taken into consideration, the inter-storey drift values exceeded the maximum allowable amount of 0.4 percent.

When compared to the raft foundation, the maximum base shear forces of the structure under the impact of the 2001 Bhuj earthquake withstood by the pile foundation rose by 71%. However, it should be noted Because the pile foundation-supported structure's base shear rose by 60.86%, The effects of the Northridge, Chi-Chi, and Kobe earthquakes were 18.72%, 76.2%, and 76.2%, respectively.

VI. SCOPE FOR FURTHER STUDIES

- **Deep foundations:**

Extensive study is limited to weak foundations for calculability and simplicity. Deep foundations are widely employed, and their depth is rising, as construction height continues to climb. As a result, it is critical to do study on deep roots interact dynamically.

- **Non-linear analysis :**

The influence of soil and buildings typically exceeds the linear elastic state, necessitating elastoplastic study. Non-linear analysis of soil-structure is required to identify the SSI issue.

- **Experimental :**

Many studies have been conducted on theoretical derivation and numerical assessment. There are few papers on the SSI experiment. As the approach of shaking table and centrifuge develops, various field and laboratory testing must be performed.

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Because the study's goal is to make recommendations for real-world initiatives, simplicity and practical applicability are essential. For engineers and designers, the current finite element method-based model is difficult and time-consuming. A less complicated method is required for application

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