International Journal of Scientific Research in Civil Engineering
© 2023 | IJSRCE | Volume 7 | Issue 2 | ISSN : 2456-6667

Analysis of Vibrational Induced Structure Considering Rail and Seismic Load Using ETABS

Vaishali Barmate[1], Amit Vishwakarma[2]
P.G. Scholar[1], Assistant Professor[2]
Department of Civil Engineering, UIT RGPV, Bhopal Madhya Pradesh, India

ARTICLEINFO

Article History:

Accepted: 15 Feb 2023
Published: 05 March 2023

Publication Issue
Volume 7, Issue 2
March-April-2023

Page Number
47-54

ABSTRACT

In the past, buildings next to railroad tracks were not taken into account when designing them, which resulted in catastrophic damage to the buildings as well as fatalities. For these structures to be designed safely, the vibrational loading must diminish.

This study's case study is the Rani Kamlapati railway station in Bhopal, which was renovated by the Bansal Group and is the nation's first private railroad station. They suggested building a business complex and other structures close to the train station. Numerous practical and theoretical methods have been put forth for the prediction of vibrations caused by trains. A 3D finite element analysis was used to represent train movement and its impact on the nearby building in order to analyse the vibration near the railway in Bhopal. The operating measurements of the high-speed train served to validate the numerical model. In the experimental study, two examples are compared: one involves a structure next to a railway track that experiences vibration, and the other involves a typical construction.

Extended Three Dimensional Analysis of Building Systems is known as ETABS. Every step of the engineering design process is integrated by ETABS.

In the current state of the building business, the built structures are observed and generally demonstrate significance positivity. These structures are referred to as members such beams and columns in multi-story R.C. structures. High-rise buildings, steel structures, and concrete structures are the principal uses of this programme. The goal of the study is to analyse a high- rise structure with 19 floors (G+18) while taking seismic, dead, and live loads into account. Strength, serviceability, and stability are the design characteristics for high-rise structures. ETABS 2016 is the name of the software version utilized. In order to compare the results for the two scenarios, comparison parameters included determining the effects of lateral loads on moments, shear force, base shear and maximum displacement on structural systems.

Keywords : Tall Structure, Seismic Load, Force, Displacement, Damping, Vibration Level, Train- Induced Vibration.

I. INTRODUCTION

In past decades, the numbers of buildings constructed close to roadway or railway are increasing due to high-density urbanization and rapid development of infrastructures in urban districts. This causes some problems in surrounding structures due to the traffic- induced ground motion effect on neighboring buildings and their influences on the normal operations of high-tech facilities. The induced ground vibration cover a range of almost 2- 200 Hz on the surface or underground. The vibration level generally depends on several factors such as vehicle weight and speed, suspension system and soil characteristics. The vibration created by railway systems close to the subterranean, ground, and elevated railway systems has an impact on building safety, people's daily lives, and the operation of high-tech products. As a result, due to the importance of the research field, it is vital to investigate induced vibration.

Overcrowding and a scarcity of construction land prompted construction along railway lines; also, overcrowding prompted vertical expansion, resulting in high-rise buildings (HRBs) with a complex reaction to various types of vibrations, particularly those caused by running trains near them. The effect of repetitive vibrations from trains moving close to HRBs may have a damaging effect on their survival. The most important aspect that might affect the values of vibrations up to the structure is the distance between the high- rise building and the railway. In the system of transitory vibrations from railways to structures, the earth is the most effective component. The measures used to safeguard buildings from the dangers of vibrations caused by running trains differ depending on the type of structure. The most well-known techniques are open and filled trenches, both of which are simple to implement and inexpensive.

Fig 1 Structure nearby railway track

For constructions that lack quake force protection, a seismic investigation should be carried out. Earthquake analysis will now take into account seismic impacts, and the specific analysis will occasionally become confusing.

However, direct static examination is sufficient for simple conventional designs. This type of research will be carried out on typical and low-ascent structures, and this approach will produce excellent results for these types of buildings. The structure's dynamic assessment will be finished, as indicated by code IS 1893-2002. (part1). Either the Response range approach or the site explicit Time history strategy will be used to finish the dynamic inquiry. The inquiry approach is carried out using the following strategies.

- Equivalent Static Analysis
- Linear Dynamic Analysis
- Response Spectrum Method
- Time History Analysis
- Pushover Analysis
- Non Linear Static Analysis
- Non Linear Dynamic Analysis

II. LITERATURE REVIEW

Regina Augusta Sampaio and Remo Magalhâes de Souza (2015) The study's findings on vibration issues in a 17-story residential building during nearby pile driving are presented in the research paper. Brazilian standards NBR6118 and NBR6123 and commercial finite element software were both used to confirm the structural design of the structure. In an experimental study, low frequency piezo-accelerometers affixed to the building structure were employed. The building's vibrations were captured in unaltered environments. Four monitoring tests were conducted on four separate days. A trial modular study was the goal of the main observation test. Information was handled in the business programming language ARTEMIS using two strategies to acquire the modular boundaries: stochastic subspace identification and frequency domain decomposition. We looked into human solace in light of ISO 2631, the international standard. The Portuguese standard, NP2074, was also used as a point of reference because it aims to limit the detrimental effects of vibrations in structures caused by pile driving close to the design.

Examinations revealed that there was tenant unease, which might be alleviated by raising the building's level of solidity. Regarding the first floor parts of the structure under study's speed records, the trial examination has demonstrated that, as defined by ISO 2631, the purposeful vibration levels are higher than the acceptable limits. However, the speed limits of the Portuguese norm, NP 2074, are not met by the principal components connected with the enterprises. The design is thus safeguarded by this measure.

Chao Zou et al (2020) In a research report, a method for focusing on the train-prompted vibration transmission from the first stage into the structures was introduced. The design of the structure also generated commotion. The technique consists of a train-track model, a model of track-soil construction, and a recreation of transmitted construction noise. Ground-improvement solutions are suggested to reduce vibration and design-transmitted noise inside structures. The impact of soil qualities on structure vibration and construction-emitted noise is dissected.

The findings demonstrate that vibration transmission is significantly influenced by the relationship between soil and construction right from the start of the project. The vibration transmitted from the ground soil up into the structure is reduced in great installations, which results in a lower degree of construction-emitted clamour. Ground improvements increase the impedance of the ground soil, which weakens the transmission of vibration and lowers the noise from the design.

Dr. K. Chandrasekhar Reddy and G. Lalith Kumar (2019) The goal of the study article was to examine a high-rise structure with 30 floors (G+30) while taking seismic, dead, and live loads into account. Strength, serviceability, and stability are the design characteristics for high-rise structures. The software version that was employed was ETABS 2016. The main objective of this study is to examine the outcomes of seismic zones 2, 3, 4, and 5 and to ascertain the impacts of lateral loads on moments, shear force, axial force, base shear, maximum displacement, and tensile forces on structural systems.

In contrast to zones 4, 3, and 2, the results showed that horizontal relocations or floats occurred more frequently in zone 5. Additionally, it was noted that the narrative shear in zone 5 is larger than it is in zone 2 based on the base responses of the design recorded in zone 5. All people were scheduled using ETABS. The product will be used to acquire the wrong people and recommend suitable locations. By using this device, the investigation can be conducted with greater accuracy.

III. Objectives of the study

The main objective of high-rise structure:

1. To determine the seismic analysis of a tall structure as per I.S. 1893:I:2016 provision.
2. To determine the effect of vibration loading over a nearby tall structure.
3. To determine the effectiveness of vibration induced structure in comparison to general structure.
4. To determine the results in terms of displacement, forces, moment and stiffness of the building.

IV. Methodology

Step 1 Defining the Grid as G+18 storey is considered with typical storey height is 3.2 m and bottom storey height is 3.2 m.

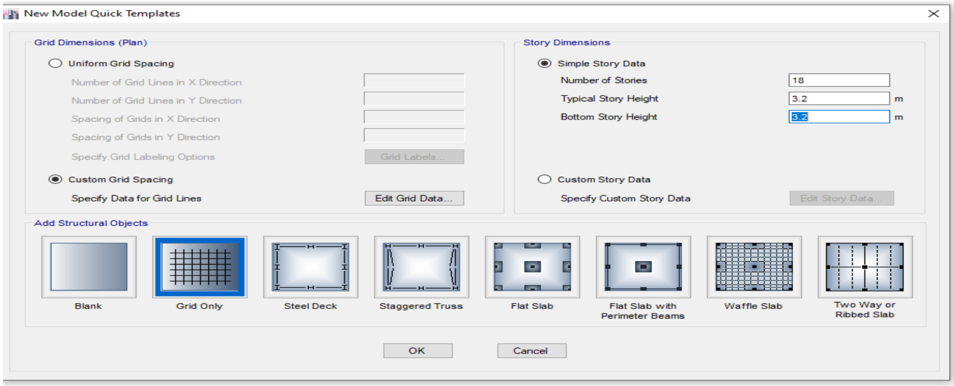


Fig 2 Defining the storey grid

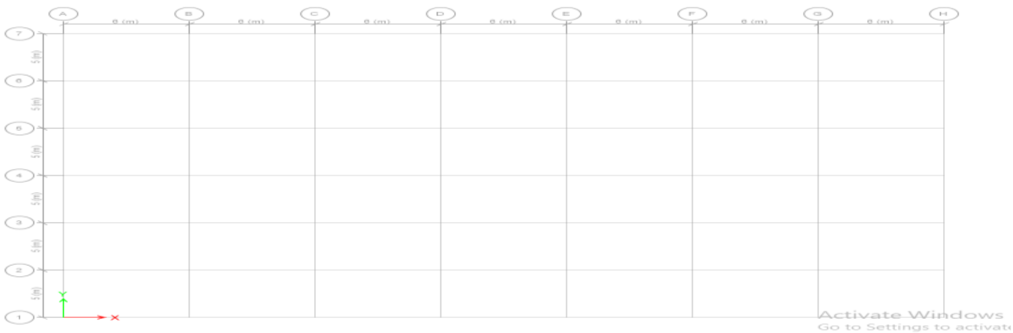


Fig 3 Floor Grid

Step 2 Defining the grid coordinates in X and Y axis. In ETABS it is generally assigned as A,B,C,B….. And 1,2,3,4….. For the other axis.This pop up provides the suitability to customize the spaces in between the grids. Which in mentioned in the diagram below.

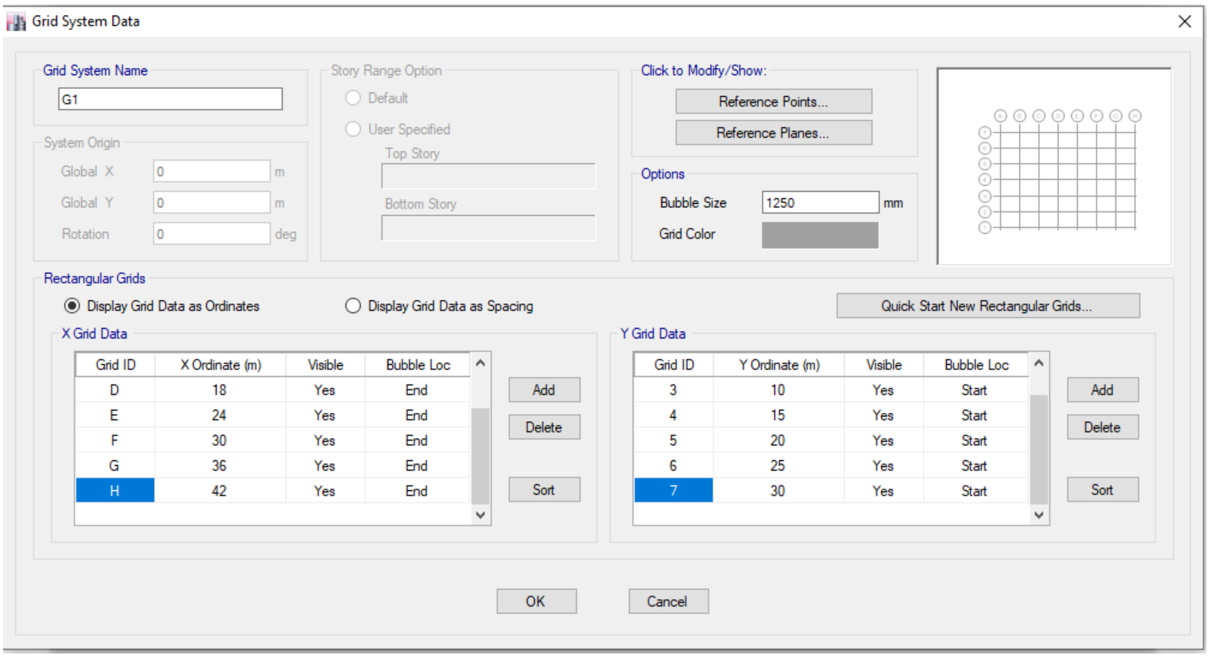


Fig 4 Defining Grid System

Step 3 Defining materials properties of beam and column. Here in this case defining the properties of grade of concrete and steel.

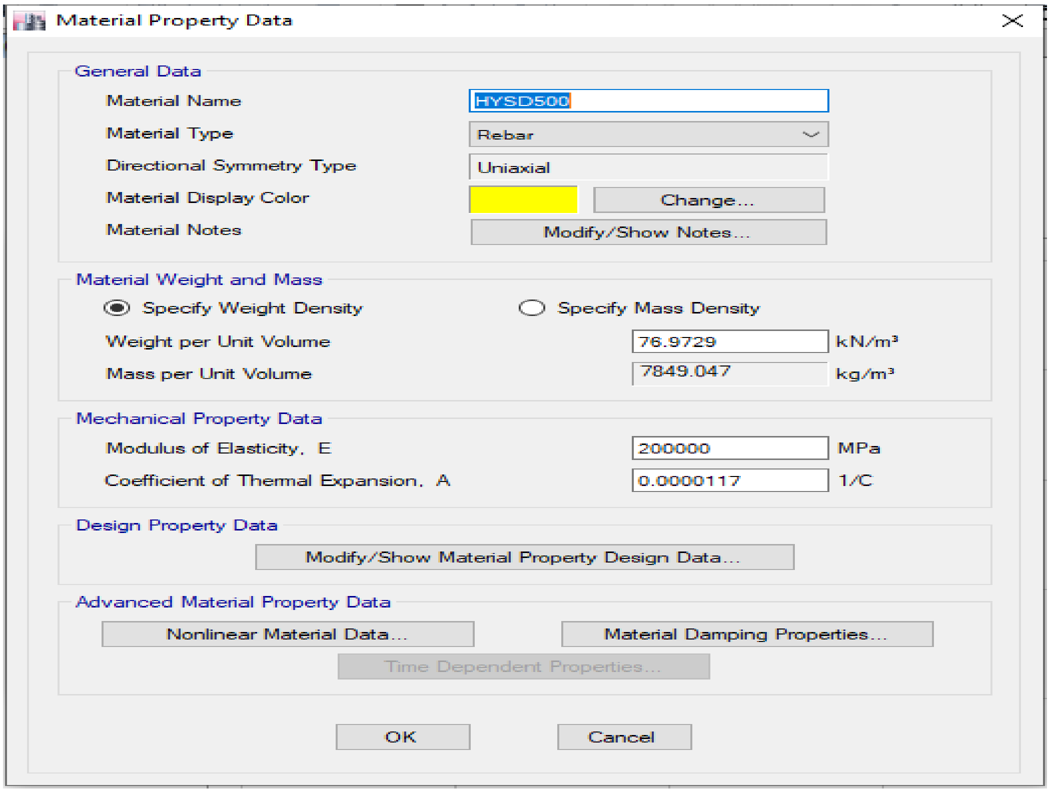


Fig 5 Defining properties of rebar.

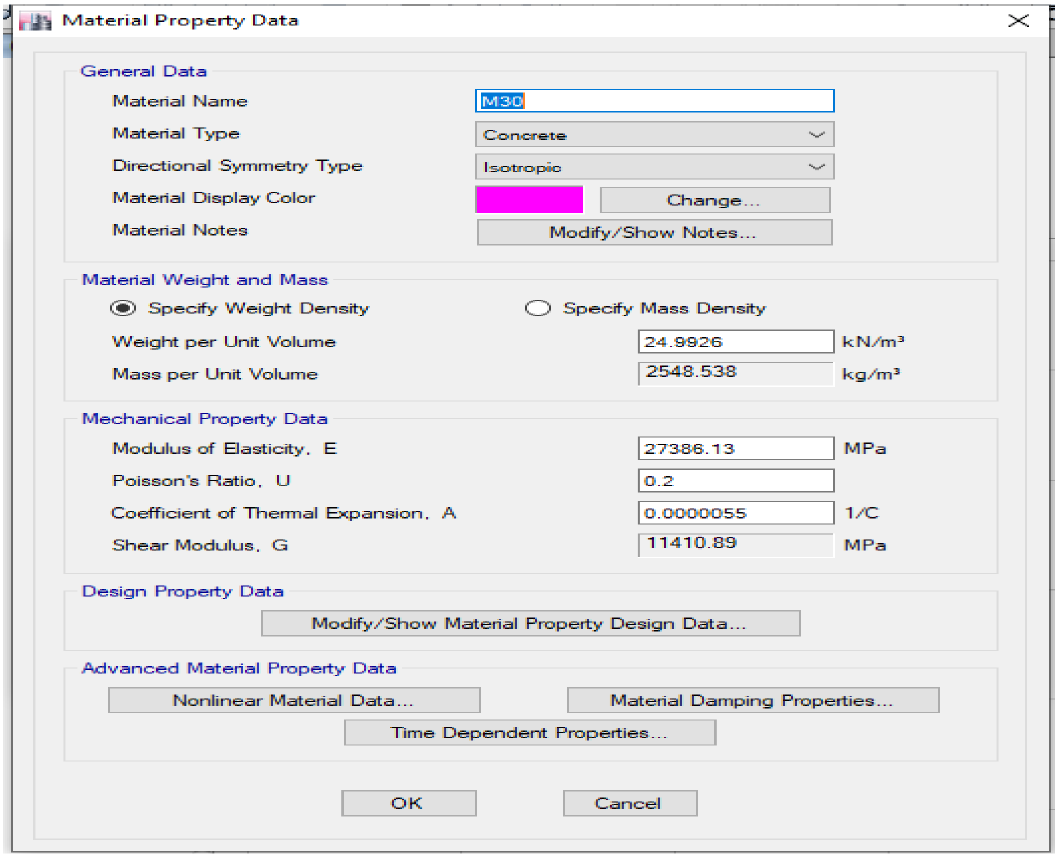


Fig 6 Defining the properties and grade of concrete.

Step 4 Defining section properties of the elements namely beam, column and slab. Size of column is considered as 500x400mm, Size of beam 400x300mm and thin slab size with thickness 150 mm.

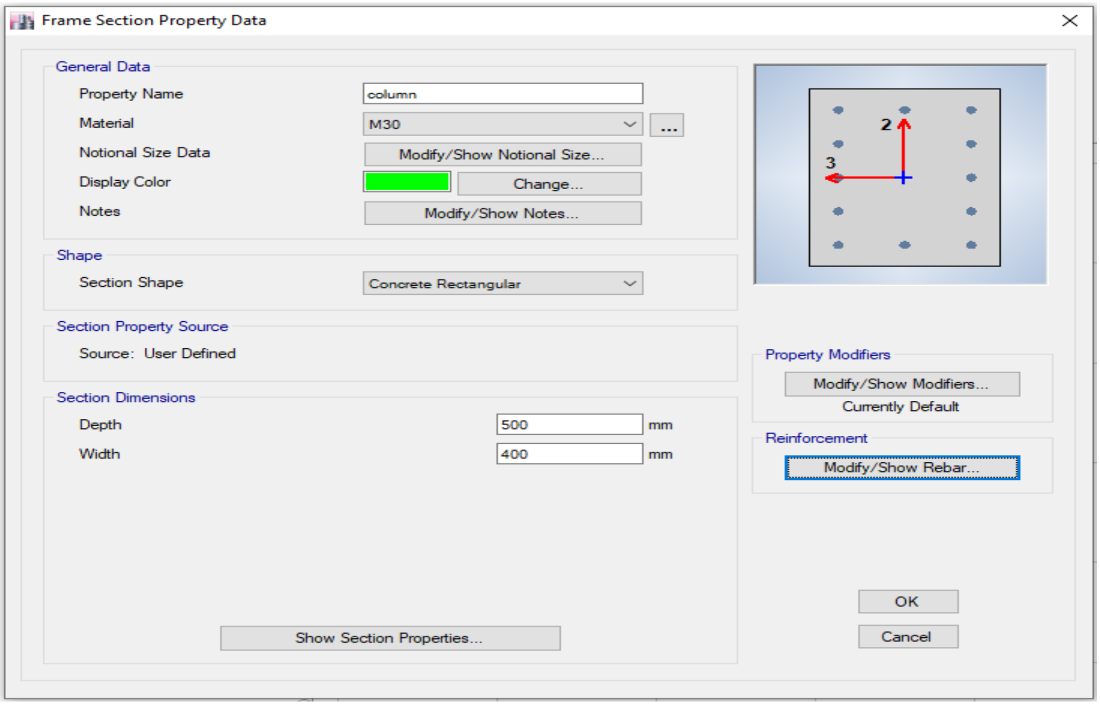


Fig 7 defining section size of the column for depth and width.

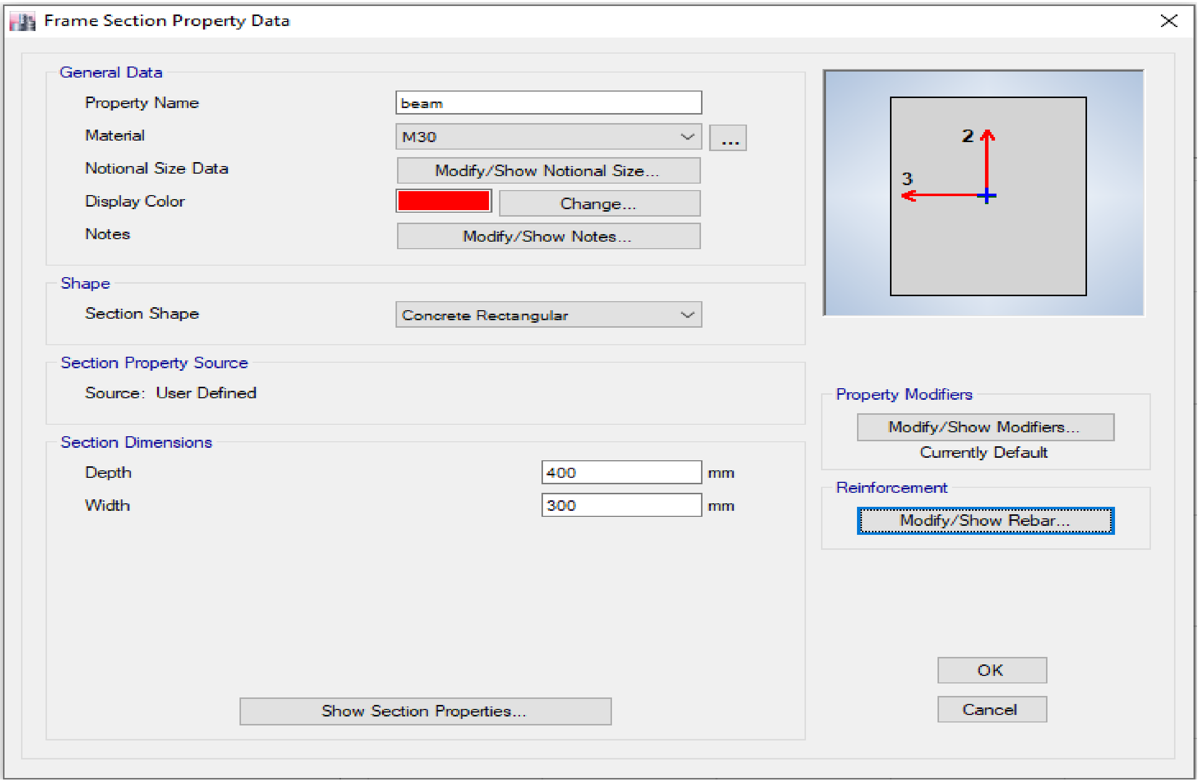


Fig 8 Defining section size of the beam.

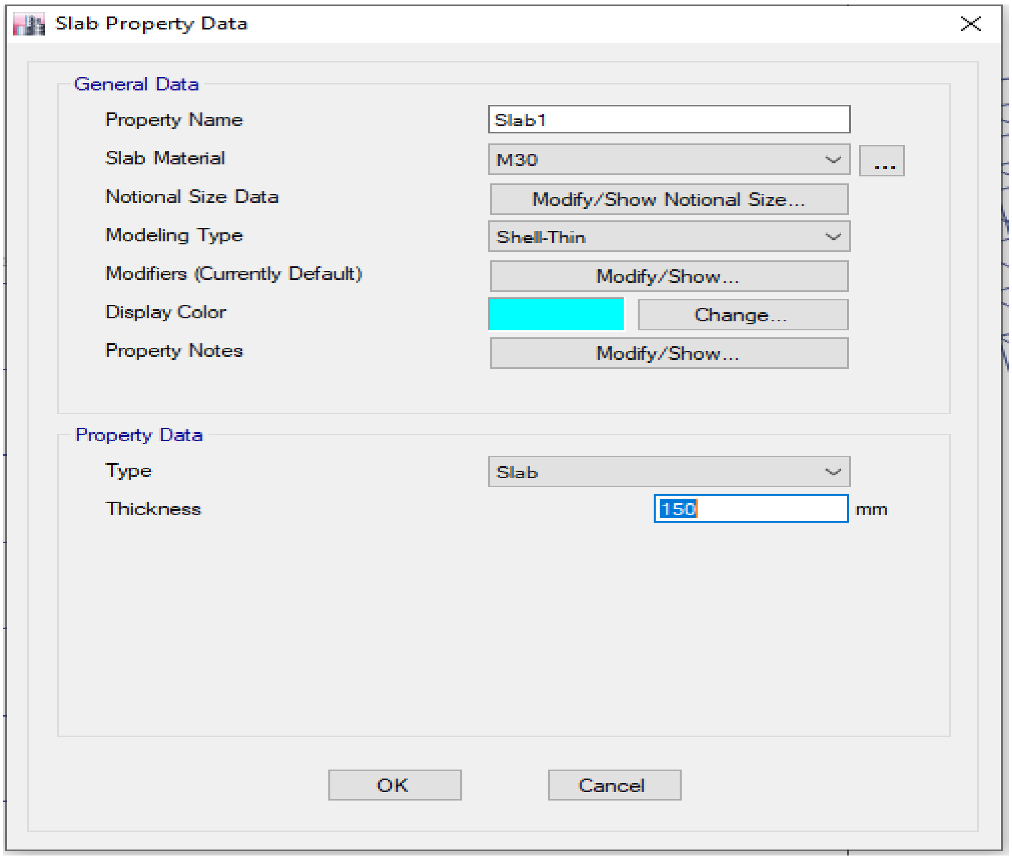


Fig 9 Defining size of the slab

Step 5. Defining loading conditions where the static and dynamic load combinations are considered. Seismic load is considered as per IS 1893:2002 where the important factor is 1

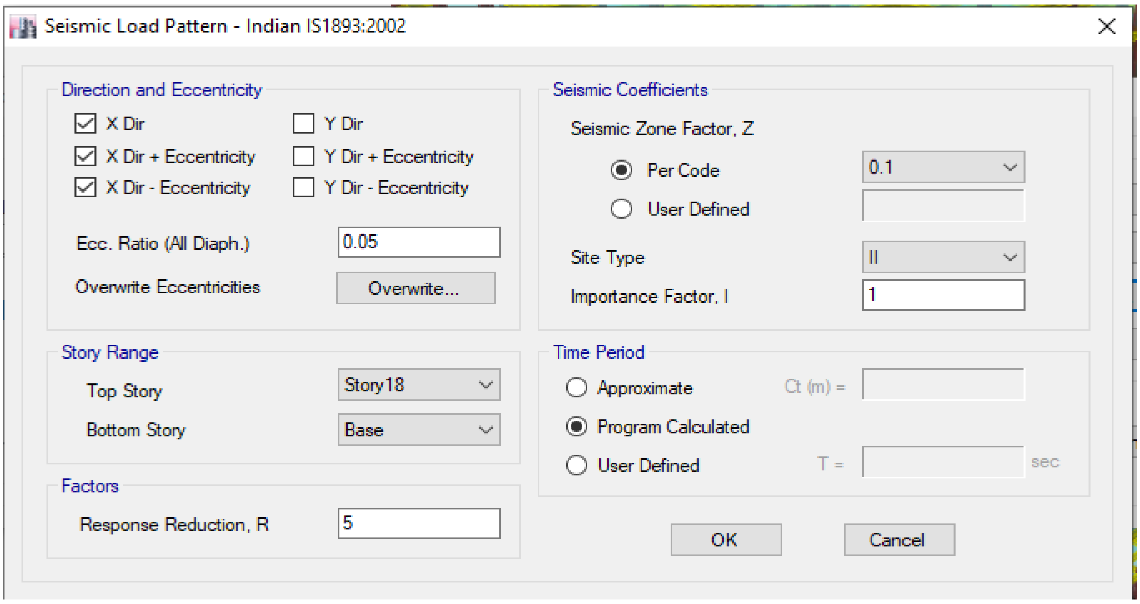


Fig 10 defining loading condition (Seismic Loading as per IS 1893:2016)

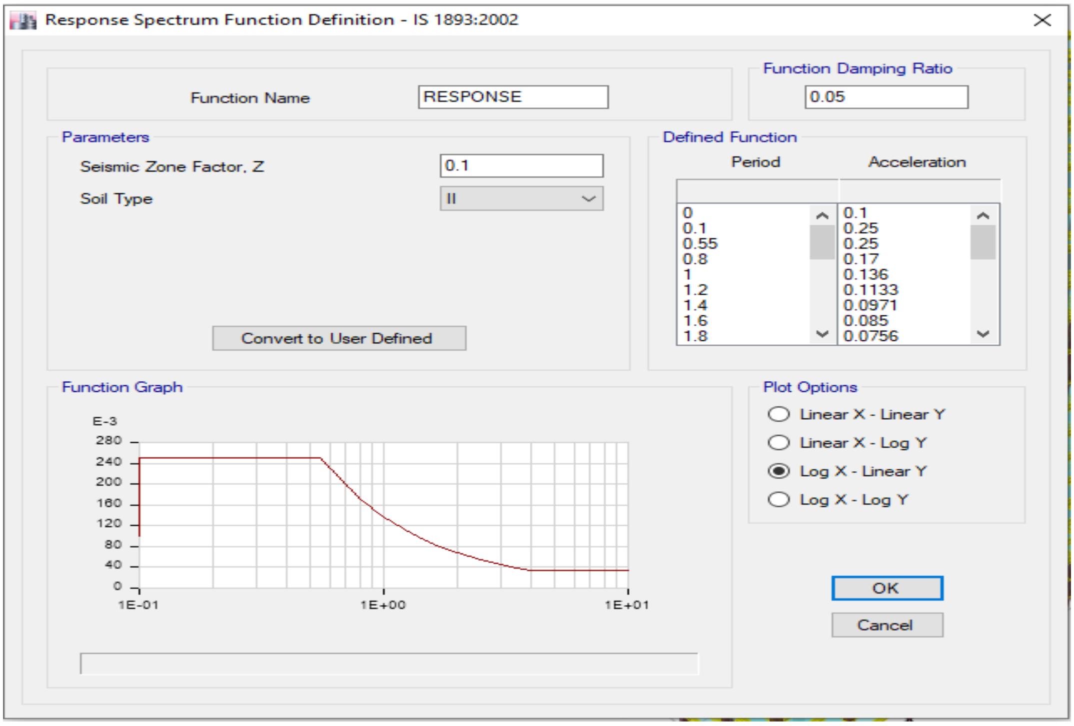


Fig 11 Response Spectrum Function

Step 6 Application of Railway Vibration.

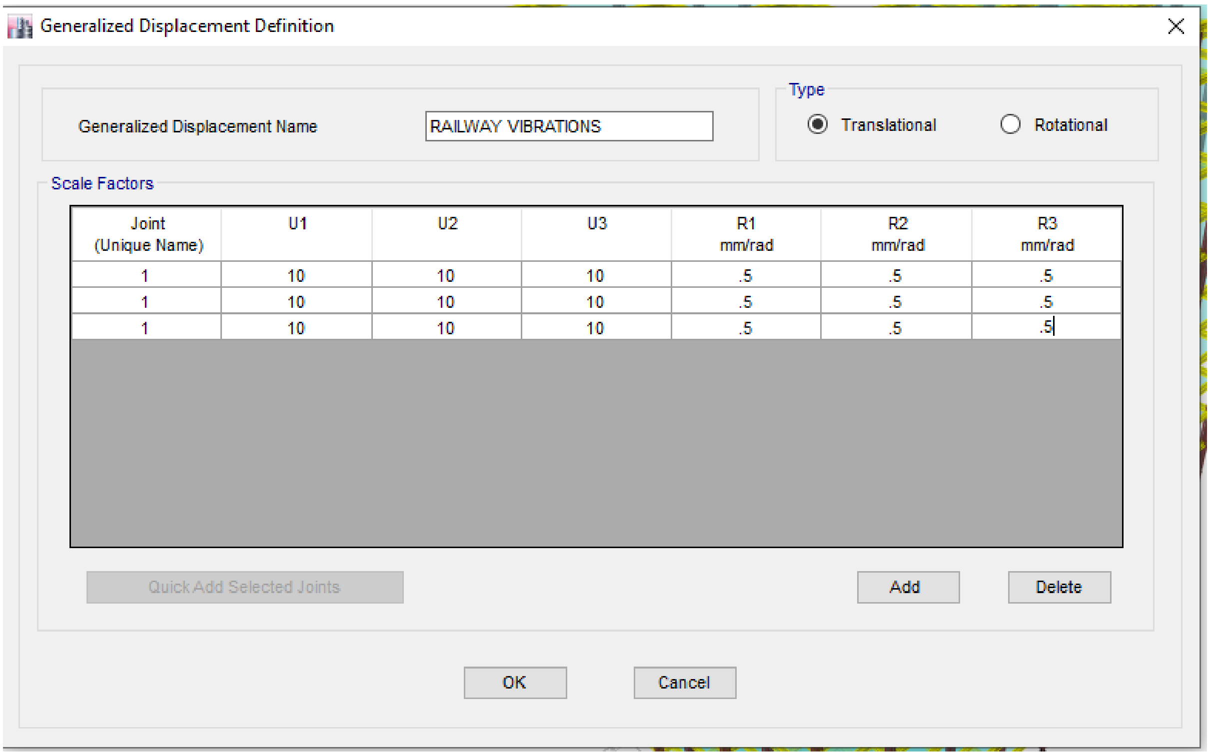


Fig 12 Generalized Displacement due to Railway Vibration

Step 7 Analysing the structure and generating the results.

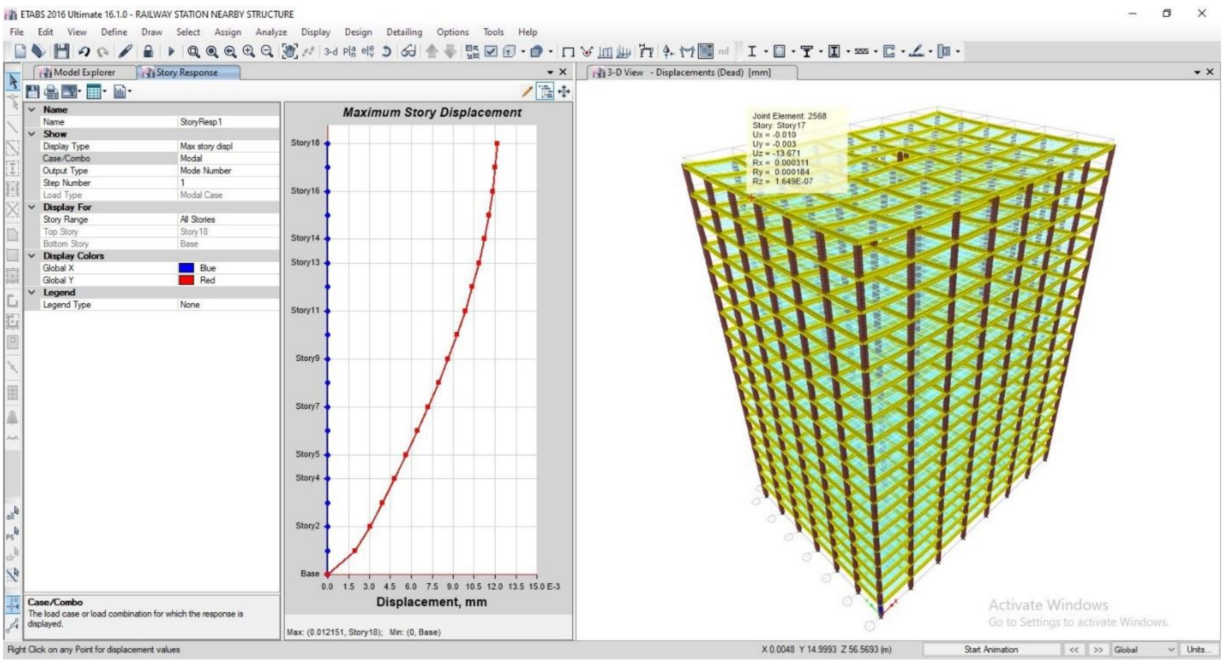


Fig 13 Stress Analysis

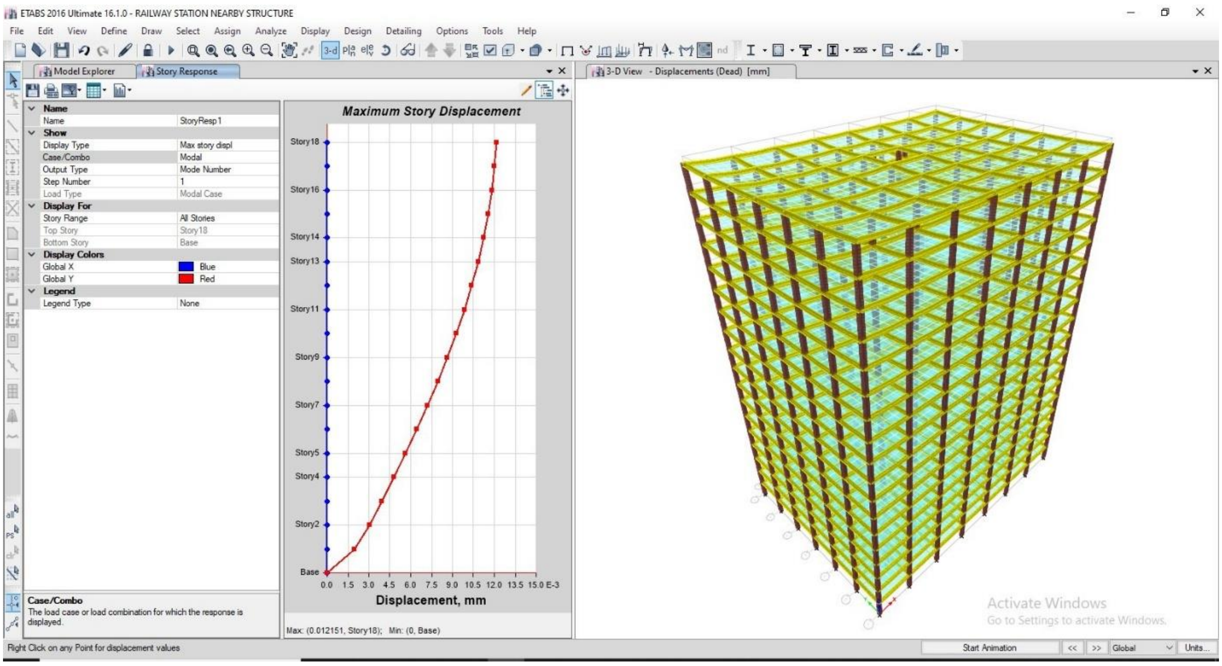
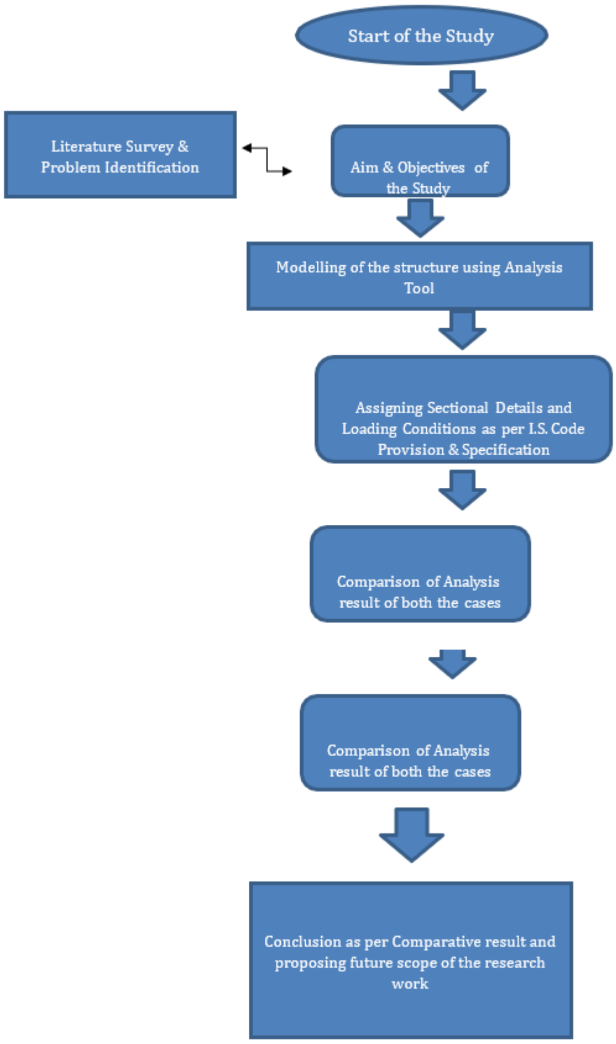
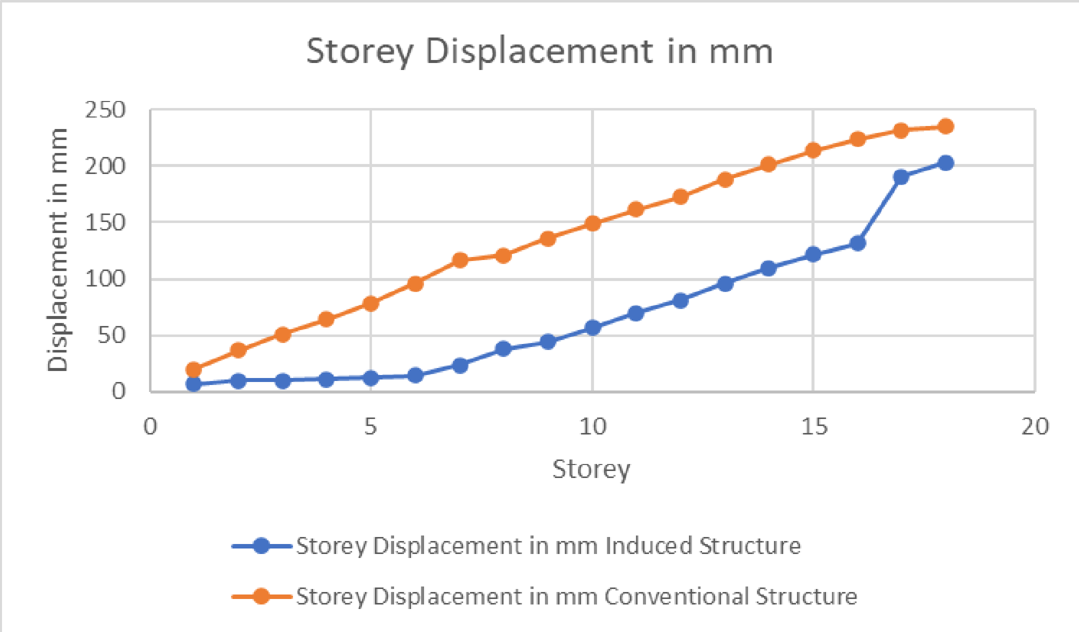
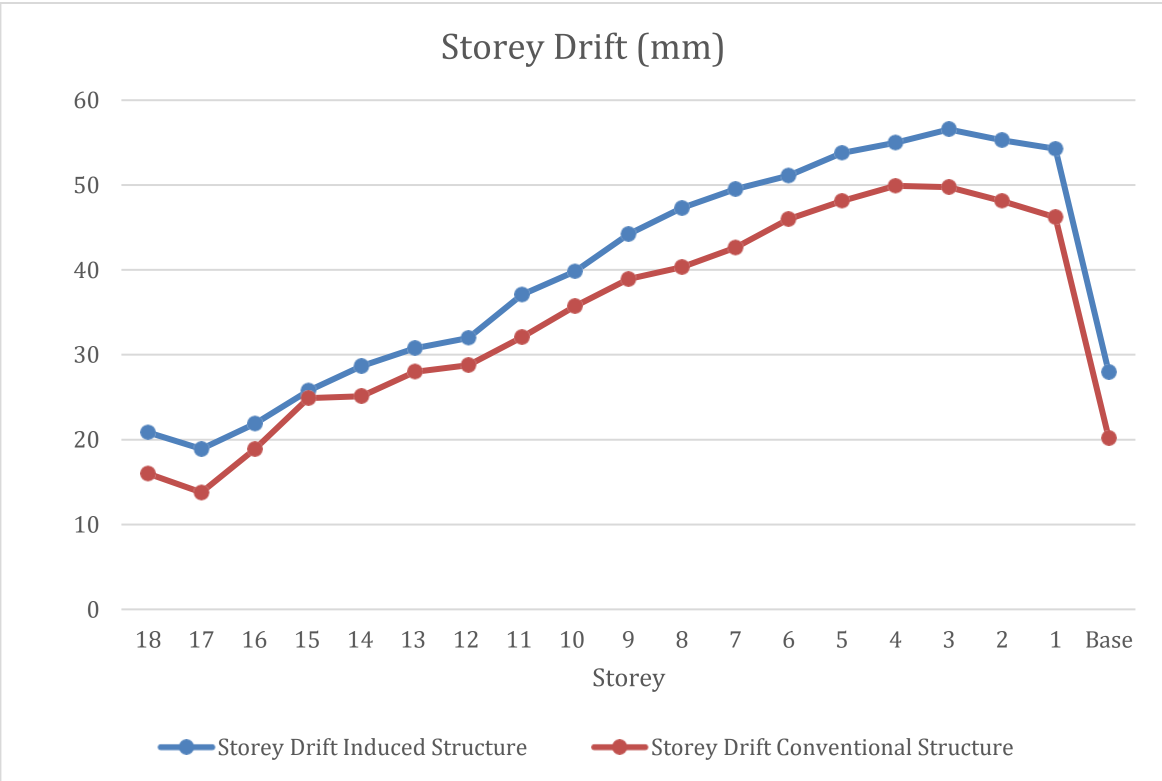


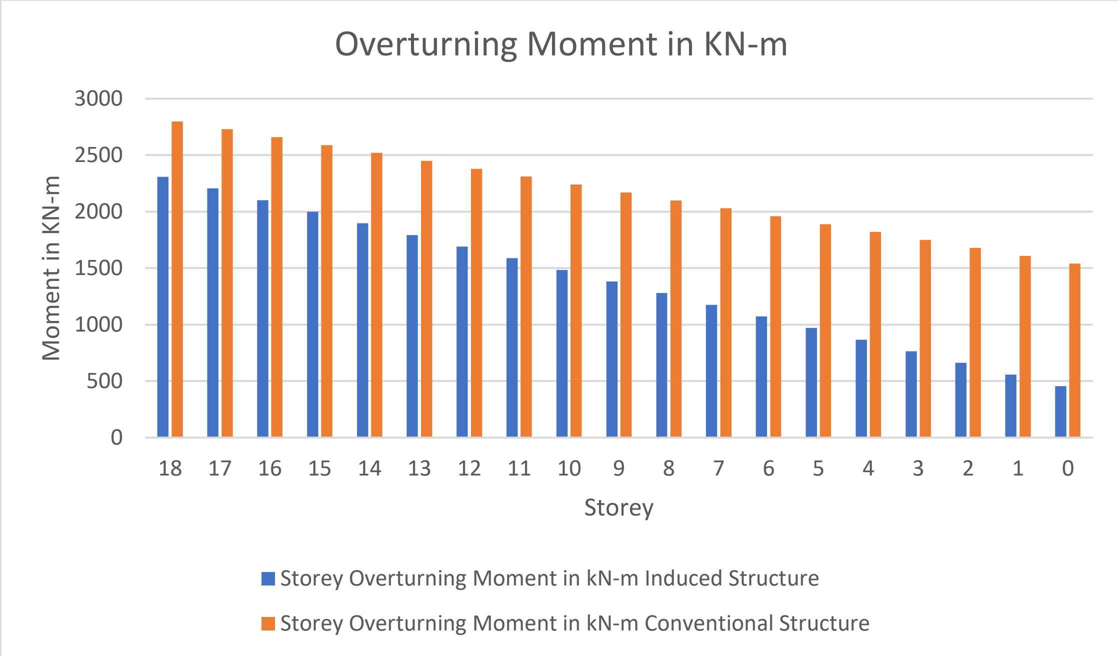
Fig 14 Value of Displacement.



V. ANALYSIS RESULT







VI. CONCLUSION

On the basis of analytical results of the study, the following conclusions were drawn:

1) Storey Displacement:

The comparative results stated that storey displacement was found maximum in case I (structure inducing vibrations due to railway tracks) and case II (conventional structure). The max storey displacement was found at storey 19 in case I as 253.2865 mm and case II was 245.1767376. The maximum or permitted storey displacement should be equal to or less than

0.4 percent of the overall building height, according to the law. As a result, the maximum allowable storey displacement is (0.4/100 x 45000) = 180 mm. For conventional building, it is 235.1767376 mm while for Induced structure it is 203.2865 mm which is comparatively less than conventional structure which shows that induced structure is more stable.

2) Storey Drift:

The variation in storey differs amongst the models' different floors. The drift of one level of a multi-story building relative to the level below is known as storey drift. In both cases of constructions, the storey drifts vary in a similar manner. For structural generated vibration, the maximum storey drift is recorded on the second floor (55.2879) and on the fourth floor (49.8989) for case II.

3) Storey Shear:

At different storey levels, the shear force is exerted. Story shear is a force measured in kN that applies on every storey in a direction perpendicular to its extension. It is highest at the bottom of both structures and declines linearly towards the top. The maximum storey shear for a conventional structure Case II is 1890 kN (Top floor), while the maximum storey shear for a structure generated vibration Case I is 1173.5 kN. (Top floor).

4) Storey Stiffness:

The difference in storey stiffness between the two models at various floor levels. Buildings' earthquake loads tend to rise in tandem with their density. The maximum horizontal load that can be applied to a structure is known as yield strength. The horizontal force spread throughout a structure is divided by the resulting lateral shear strain in the building to calculate Storey stiffness (usually called drift). For both constructions, storey stiffness varies non-linearly. The maximum storey stiffness for Case II (first and second floors is 171.609 kN/m, while the maximum storey stiffness for Case I is 203.504 kN/m (first floor and second floor).

5) Storey Overturning Moment:

Both models have various storey overturning moments at different floor levels. The moment of energy capable of upsetting the storey of a building is the point at which the storey has been subjected to enough disturbances that it ceases to be stable, overturns, capsizes, collapses, topples, and eventually the structure falls. Both structures are safe because there are no positive overturning moments and only a minor negative overturning moment towards the base 2800 kN/m for conventional structure at ground floor and 2309 KN/m for structure induced vibration case II at ground floor level) both of which can be approximated to zero. Hence it can be assumed that both the structures have zero overturning moments and are hence safe.

As a result, both structures are believed to have zero overturning moments and are hence safe.

Building generated vibrations showed larger displacements, storey drifts, and storey shears than conventional buildings, implying that buildings near railway tracks display the most displacement and storey drift.

In general, displacements increase linearly with building height; maximum storey drift is observed at second floor for Case I structure and fourth floor for Case II structure; maximum storey shear force was observed between ground floor and second floor for conventional structure and at ground floor for Case I structure, and the value decreases linearly with height; storey stiffness varies non-linearly for both structures with maximum values at ground floor for both structures; maximum storey shear force was observed between ground floor and second floor for conventional structure and at ground There are also no or very few overturning moments.

Summary:

In this study it is concluded that vibration induced structure is more stable in terms of resisting lateral and vibration load. Induced structure is a combination of flat slab and post tensioning beams utilized in this study shows that as compared to conventional structure is resisting vibrational loading as observed in above chapter resisting load and making structure stiffer and more stable. In this study we observed the results in terms of overturning moment, shear, drift, displacement and storey stiffness and concluded that vibration induced structure is comparatively 18% more stable.

VII. REFERENCES

[1]. Regina Augusta Sampaio and Remo Magalhâes de Souza, [VIBRATION ANALYSIS OF A RESIDENTIAL BUILDING], MATEC Web of Conferences, (2015).

[2]. Chao Zou, Yimin Wang and Ziyu Tao, [Train-Induced Building Vibration and Radiated Noise by Considering Soil Properties], Sustainability 2020, 12, 937.

[3]. DR. K. CHANDRASEKHAR REDDY and G. LALITH KUMAR, [Seismic Analysis of High-Rise Buildings (G+30) by Using ETABS], International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES), Volume 5, Issue 03, March- 2019.

[4]. Denise-Penelope N. Kontoni and Ahmed Abdelraheem Farghaly, [Mitigation of train- induced vibrations on nearby high-rise buildings by open or geofoam-filled trenches], JOURNAL OF VIBROENGINEERING. MARCH 2020, VOLUME 22, ISSUE 2.

[5]. Sayyed Javad and Hamane Ajay A, [COMPARATIVE STUDY OF SEISMIC ANALYSIS OF VARIOUS SHAPES OF BUILDING BY INDIAN CODE AND AMERICAN CODE], International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 05 | May-2018.

[6]. Bhalchandra p. Alone and Dr. Ganesh Awchat, [Study on seismic analysis of high-rise building by using software], International Journal of Scientific Development and Research (IJSDR), August 2017 IJSDR | Volume 2, Issue 8.

[7]. Albert Philip and Dr. S. Elavenil, [SEISMIC ANALYSIS OF HIGH RISE BUILDINGS WITH PLAN IRREGULARITY], International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 4, April 2017.

[8]. R.Kazi, P.V.Muley and P.Barbude, [Comparative Analysis of a Multistorey Building with and without Damper], International Conference on Quality Up-gradation in Engineering, Science and Technology (ICQUEST2015).

[9]. Vinay Agrawal, Rajesh Gupta and Manish Goyal, [A Study on Seismic Analysis of High Rise Irregular Floor Plan Building with Different Position of Shear Walls], International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-6 Issue-6, August 2017.

[10]. Nan Jiang, Yuqi Zhang, Chuanbo Zhou, Tingyao Wu and Bin Zhu, [Influence of Blasting Vibration of MLEMC Shaft Foundation Pit on Adjacent High-Rise Frame Structure: A Case Study], Energies 2020, 13, 5140.

Cite this article as :

Vaishali Barmate, Amit Vishwakarma, "Analysis of Vibrational Induced Structure Considering Rail and Seismic Load Using ETABS", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 7, Issue 2, pp.47-54, March-April.2023
URL : https://ijsrce.com/IJSRCE23727