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Seismic Response of Regular And Irregular Buildings with Different Soil Conditions

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ABSTRACT

The main objective of this study is to find out seismic response of regular and irregular buildings with vertical irregularity i.e. stiffness irregularity in zone prone to higher seismic disturbances. Most of the civil engineering structures involve some type of structural element with direct contact with ground. When the external forces, such as earthquakes, act on these systems, neither the structural displacements nor the ground displacements, are independent of each other. Response of the soil influences the motion of the structure and the motion of the structure influences the response of the soil this process is termed as soil-structure interaction. Due to earthquake, failure of structure occurs and it starts at weak part of the structure. Also the weakness in structure occurs due to discontinuity in mass, stiffness and geometry and such type of structures comes under the category of irregular structures and study of these types of structures is necessary so that loss to human life can be minimized.

INTRODUCTION

Soil structure interaction is quite important area of research in structural engineering now days. Soil structure interaction is a process in which motion of structure is influenced by the response of the soil and the response of the soil is influenced by motion of structure. Due to earthquake, failure of structure occurs and it starts at weak part of the structure. Also the weakness in civil engineering structures occurs due to discontinuity in mass, stiffness and geometry and such type of structures comes under the category of irregular structures. During an earthquake, the major reason due to which a structure fails is the vertical irregularity. The analysis and designing part of structure becomes more difficult and complicated when these structures are constructed in high seismic prone zones i.e. zone IV or zone V.

Soil Structure Interaction

The vast majority of the structural building structures include some assortment of basic part with coordinate contact with ground. Once the external forces, similar to earthquakes, follow up on these frameworks, neither the structure displacements nor the ground displacements, are autonomous of each option. The procedure inside which the response of the soil affected the movement of the structure and in this manner the movement of the structure impacted the response of the soil is named as soil-structure interaction (SSI).

Regular And Irregular Buildings

Building which is having symmetry and continuity in geometry, mass or load resisting element comes under the category of regular building.

Building in which symmetry lacks and has discontinuity takes place in geometry, mass, or load resisting element comes under the category of irregular building.

Importance of Finite Element Analysis

- Complete and comprehensive result sets, developing the physical response of the system at any location, including some which might have been neglected in an analytical approach.
- Safe and secure simulation of potentially destructive, dangerous or impractical load conditions and deterioration modes.
- Excellent adoption of a model. Often, many failure modes or physical events can be tested within a familiar or common model.

- The concurrent calculation and visual representation of a wide variety of physical parameters such as temperature or stress, enabling the designer to speedily analyze performance and possible adjustments.
- Estimation of existing experimental conclusions via parametric analyses of validated models.
- Comparatively low investment and very fast calculation time for most applications.

LITERATURE REVIEWS

B. Pallavi Ravishankar1, 2013. Tall uneven structures encounter extra hazard all through the tremors (Ming, 2010). This happens basically because of attenuation of earthquake waves and local site reaction that get exchanged to the structure and contrariwise. This might be clarified by the Dynamic Soil Structure Interaction (DSSI) examination. amid this examination paper 150m tall asymmetrical building with 2 totally unique foundation frameworks like raft and pile is considered for investigation and accepting homogenized sandy soil strata comes about are contemplated for contribution of Bhuj ground movement (2001, M=7.7).

Chinmayi H.K.2, 2013. During earthquake the behavior of any structure is influenced not only by the response of the structure, however additionally by the response of the soil which is inside or beneath the ground. Structural which gone under failures or collapse condition in past have shown the importance of soil-structure interaction (SSI) effects.

Ramesh Baragani3, 2014. In spite of the fact that the structures are supported on soil, the vast majority of the basic planners don't consider the SSI effect all through a seismic tremor. Totally unique soil properties will affect seismic waves as they go through a soil layer. At the point when a structure is subjected to relate seismic tremor excitation, it interfaces with the establishment and soil, and in this manner changes the movement of the ground. It suggests that the shaking of the aggregate ground structure framework is affected by assortment of soil and furthermore by the type of structure.

Renu Raghuveeran6, 2015. In the past couple of decades, it's been perceived that Soil Structure Interaction (SSI) adjusted the response attributes of a structural system because of tremendous and stiff nature of structure and, regularly, soil softness. The present investigation endeavors to call attention to the response of a structure in earthquake analysis by considering the consequence of soil structure interaction.

Sakshi Singh8, 2016. A tremor is the unmistakable trembling of the surface of the earth, which brings about the sudden arrival of kinetic energy as seismic waves. It might be sufficiently savage to make harms structures and therefore result in great human setbacks in conjunction with the huge monetary misfortune.

Method For Seismic Analysis of Buildings

1) Equivalent Static Analysis.
2) Response Spectrum Analysis.
3) Pushover Analysis.
4) Time History Analysis.

Equivalent Static Analysis

Equivalent static analysis is a simplified method used in structural engineering to determine the seismic (earthquake) demands on a building. It converts complex, time-varying dynamic earthquake forces into a set of static lateral forces that are applied to the structure to estimate its maximum stress and deformation.

Response Spectrum Analysis

Response Spectrum Analysis (RSA) as per IS 1893 (Part 1) is a linear dynamic method used to calculate the peak seismic response (displacements, member forces) of a structure. It models the building using its natural modes of vibration, utilizing a standard design acceleration spectrum that accounts for the building's period, seismic zone, and soil type.

Pushover Analysis

A pushover analysis is a static, nonlinear procedure using a simplified, nonlinear technique to estimate seismic structural deformations. It is an incremental static analysis which is used to determine the force-displacement relationship – or the capacity curve – for a structure or structural element.

Time History Analysis

Time history technique a structure’s response to an earthquake at each moment in time. To do the seismic analysis, a variety of seismic data are needed, such as acceleration, velocity, displacement etc., which can be efficiently obtained from the study of seismograph data for any given earthquake.

WORK METHODOLOGY

In the present study the analysis has been done for a G+8 story building using ETABS 2022. Finite element analysis was done using the Response spectrum method. The properties for the model created are as given below.

Description of Building

Table For Geometrical Properties:

Plan dimension	16X16 m^2
No. of stories	G+8
Floor to floor height	3m
Beam size	0.3mX0.6m
Column size	0.35X0.6m
Thickness of slab	0.15m

Table For Material Properties:

Grade of concrete	M30/M40
Grade of steel	Fe550
Density of concrete	25 kN/m^3

Structural Modelling
Structural modeling plays a crucial role in analysis of structure. Thus, two irregular and one regular model of G+ eight floors in height are modelled in this study.

This chapter provides a step-by-step explanation of the structural modelling process. Additionally, this chapter includes step-by-step screenshots (figures) of the modelling using E-TABS-2022.

Steps of Modeling

1. Creation of new model
2. New model template
3. Command defining
4. Drawing commands
5. Assigning commands
6. Analysis of model

RESULTS AND CONCLUSION

Story Displacement
The results shows that the behavior of model I and III i.e. the regular building and the building without slab on ground floor are almost the same but model II i.e. the building with plan (geometric irregularities) shows the least value for story displacement for all types of soils.

Story Drift
The results shows that the behavior of model I and III i.e. the regular building and the building without slab on ground floor are almost the same but model II i.e. the building with plan (geometric irregularities) shows the Higher value for drift index for all types of soils.

Base Shear
Model 1 i.e. regular building gives the maximum values of base shear for all the three types of soil i.e. hard, medium and soft soil, model 3 i.e. irregular building without slab on story 1 gives a higher value of base shear as compared to model 2.

Story Stiffness

Model 2 i.e. without slab on story 1 gives the maximum value of story stiffness. Model 1 i.e. regular building gives a higher value of story stiffness as compared to model 3.

Conclusion

On the basis of the results of analysis of regular & irregular buildings under different soil conditions, the following conclusions are drawn:

- Value of Story displacement in model II is the lowest in comparison to model I & III.
- Story drift in model I & III is higher than model II.
- Base shear in regular building i.e. model I is maximum and model III shows higher value than model II.
- Story stiffness in regular building is greater than other three models.

REFERENCES

1. Pallavi Ravishankar, Dr D Neelima Satyam, "numerical modeling to study soil structure interaction for tall asymmetrical building", International Conference on Earthquake Geotechnical Engineering, Istanbul, Turkey,Report No: IIIT/TR/2013/-1.
2. Chinmayi H.K., Jayalekshmi B.R, "Soil-Structure interaction effect on seismic response of a16 storey RC framed building with shear wall." American Journal of Engineering Research, Volume-2, 2015, pp.53-58.
3. Ramesh Baragani, Dr.S.S.Dyavanal, "Performance Based Seismic Evaluation of G+6 RC Buildings Considering Soil Structure Interaction", International Journal of Engineering Trends and Technology (IJETT) – Volume 14 Number 3 – Aug 2014.
4. Shreya Thusoo, Karan Modi, Rajesh Kumar, Hitesh Madahar, "Response of Buildings with Soil Structure Interaction with Varying Soil Types",International Journal of Civil,Environmental, Structural, Construction and Architectural Engineering, Volume-09, No- 4, 2015.
5. Kuladeepu M N, G Narayana, B K Narendra, "ssi effect on dynamic behavior of 3D building frames with raft footing", IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
6. Renu Raghuveeran, Hashifa Hassan P, " Seismic Soil Structure Interaction Effects on RC Bare Frames Resting on Pile-Grid Foundation", International Journal of Scientific and Research Publications, Volume 5, Issue 10, October 2015 1 ISSN 2250-3153.
7. Mr. Rahul Sawant and. M. N. Bajad (2016), "Effect of Soil-Structure Interaction on High Rise RC Building". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 13, Issue 1, pp 85-91