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ANALYSIS & DESIGN OF RESIDENTIAL BUILDING AGAINST GRAVITY & SEISMIC LOADS USING STAAD PRO SOFTWARE

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ABSTRACT

Analyzing a G+4 residential building against gravity and seismic loads involves a comprehensive assessment of the building's structural integrity to determine its ability to withstand both types of loads. The first step in analyzing a G+4 residential building is to determine the building's load-carrying capacity. This involves calculating the maximum load that the building's structural elements, such as columns, beams, and slabs, can support without failure. This calculation takes into account the building's dimensions, the materials used, and the design of the structural elements. Gravity loads are the static loads that act on a building due to the weight of its components, including the building's own weight, the weight of the occupants, and the weight of the contents. The gravity load calculation involves calculating the weight

of all building components and distributing them throughout the building's structural elements.

Seismic loads are the dynamic loads that a building experiences during an earthquake. The seismic load calculation involves determining the building's seismic zone and the maximum earthquake ground motion that the building could experience. This information is then used to calculate the building's seismic loads, which are distributed throughout the building's structural elements. Once the gravity and seismic loads have been calculated, a structural analysis is performed to determine if the building's structural elements can support these loads without failure. This involves calculating the stress and deformation of each structural element

under the combined effect of the gravity and seismic loads.

I. INTRODUCTION

Design reinforcement measures if the structural analysis reveals that some of the building's structural elements are not able to withstand the combined effect of the gravity and seismic loads, reinforcement measures must be designed. This can involve adding additional structural elements, increasing the size or strength of existing structural elements, or using specialized materials to improve the building's structural integrity. The final step in analyzing a G+4 residential building against gravity and seismic loads is to review and approve the design and reinforcement measures. This may involve obtaining permits and approvals from local building authorities, as well as ensuring that the building meets all relevant building codes and standards. Overall, analyzing a G+4 residential building against gravity and seismic loads is a complex process that requires specialized knowledge and expertise. It is important to engage the services of a qualified structural engineer to ensure that the building is safe and structurally sound.

The seismic codes are prepared with consideration of seismology of country, accepted level of seismic risk, properties of construction materials, construction methods, and structure typologies etc. Furthermore, the provisions given in seismic codes are based on the observations, experiments & analytical case studies made during past earthquakes in particular region.

II. LITERATURE STUDY

i. **Mr. K. Lovaraju et al (2015)** He studied the effective location of shear wall on performance of building frame subjected to earthquake load. In this paper, four types of structures with G+7 are considered in which one of the frames without shear wall and three frames with shear wall in various positions. The Non-Linear Static analysis is done using ETABS v9.7.2 software.

ii. **Md. RashedulKabir et al (2015)** He has determined response of multi-storey regular and irregular buildings of identical weight under static and dynamic loading in context of Bangladesh. In this paper, 15 storied regular shaped and irregular shaped buildings have been modelled using program ETABS 9.6 for Dhaka (seismic zone 2), Bangladesh. The effect of static load, dynamic load and wind load is analysed. The mass of each building was considered to be same. Displacement due to wind load is maximum in all type of buildings.

iii. **Zoi C. Tetta, Lampros N. Koutas and Dionysios A. Bournas (2016)** presents an experimental study on shear strengthening of rectangular reinforced concrete (RC) beams with advanced composite materials. Key parameter included in the paper is to strengthen the structural system by namely textile-reinforced mortar (TRM) jacketing. Results obtained in the paper reveal that considerably there is higher effectiveness when two layers of TRM jackets are used for strengthening.

iv. **Hasan Kaplan and Salih Yilmaz (2011)** dealt with the problems related with the global ductility, stiffness or strength of the structure with the main concern and also suggested global strengthening techniques are more advantageous for retrofitting. But stated that element-based techniques are more economical solutions when local problems are the main reason of the strengthening decision and if necessary both approaches can also be utilized.

v. **Condition assessment of buildings for repair and upgrading, Prepared by National Disaster Management Division Ministry of Home Affairs (2007)** The main purpose of this guide is to briefly describe how to carry out the condition assessment of buildings before taking up repair and upgrading work. This will determine whether or not a distressed building should be demolished to build back better or whether it will be cost-effective to either repair or retrofit it, in the context of overall safety.

vi. **Uma Shankar. K, Arun Prakash. K and Pradeep Kumar. S (2015)** studied a seven story non-ductile concrete framed building was proposed to seismically upgrade. Analysis results revealed that the structures did not have sufficient structural capacity to resist even a moderate earthquake. To ensure a higher level of safety, reduce the risk of exorbitant repair costs and minimize building downtime after an earthquake, it was intended that the seismic upgrade of the structural system will target the performance standard of immediate occupancy. Thus, Retrofitting reduces the vulnerability of damage of an existing structure during a future earthquake. It aims to strengthen a structure to satisfy the requirements of the current codes for seismic design.

vii. **Mr. S. Mahesh & Mr. Dr. Pandurang a Rao et. al. (2014). Comparison of analysis and design of regular and irregular configuration of multi storey building in various seismic zones and various types of soils using ETABS and STAAD.** Studied a residential of G+11 multi-storey building for earth quake and wind load using ETABS and STAAS PRO V8i. Assuming that material property is linear static and dynamic analysis is performed. These analyses 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 is plotted for different zones and different types of soils.

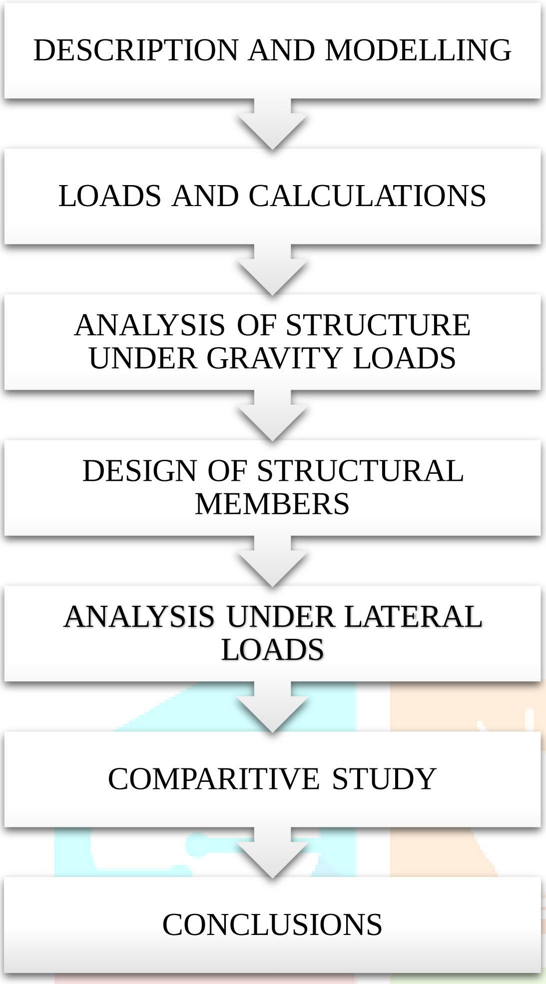
III. BUILDING SPECIFICATIONS

Properties	Values
Height of building	15m
Each storey height	3m
No of storeys	4
Size of column	0.23 × 0.45 m
Size of beam	0.23 × 0.45 m
Slab thickness	0.13m
Size of wall	0.23 m
Seismic zone	Zone-III
Zone factor	0.16

IV. MATERIAL AND LOAD SPECIFICATIONS

Property of material	values
Grade of concrete	M_{25}
Grade of steel	FE_{415}
Unit weight of concrete	$25kN/m^3$
Unit weight of brick	$19.2kN/m^3$
Live load (on roof)	$1.5kN/m^2$
Floor finish (on roof)	$1.75kN/m^2$
Live load (at floor level)	$3kN/m^2$
Floor finish (at floor level)	$1.25kN/m^2$

V. METHODOLOGY



VI. COMPARISON OF RESULTS BETWEEN GRAVITY AND EARTHQUAKE LOADS

	Gravity loads	Earthquake loads	percentage of variation (%)
Displacement (mm)	0.65	12	179.466
Shear (kN)	111.6	580	135.454
Lateral ties spacing (mm)	150	65	79.06

VII. COMPARISON OF RESULTS BETWEEN STAAD PRO AND MANUAL CALCULATIONS

Parameter	Manual	STAAD pro	percentage of variation (%)
Load on critical column (kN)	900	935	3.81
Moment in Beam (kN-m)	58.13	61.68	5.92
Area of steel in Column (mm^2)	828	828	0
Area of steel in Beam (mm^2)	337	481.81	19.61

VIII. CONCLUSION

- Seismic analysis is a critical aspect of structural design, as it is important to ensure that a building or structure can withstand earthquakes and other seismic events.
- STAAD Pro is a powerful software tool that can be used for seismic analysis, as it provides a range of features and capabilities that can help engineers to model and analyze structures under seismic loads.
- In conclusion, the use of STAAD Pro software for seismic analysis can provide a number of benefits, including the ability to quickly and accurately model complex structures, simulate earthquake events, and evaluate the behavior of the structure under different loading conditions.
- However, it is important to note that the accuracy of the analysis depends on the quality of the input data and the assumptions made during the modeling process.

- Therefore, it is essential to have a thorough understanding of the software and the underlying principles of seismic analysis in order to ensure that the results are reliable and meaningful.
- The G+4 residential building has been analyzed and designed using STADD. Pro.
- Seismic forces have been addressed, and the construction has been constructed to with stand earthquakes.
- Finally, STADD Pro is a versatile software that can calculate the reinforcement needed for any concrete section depending on its loading as well as nodal deflections against lateral forces.

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