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COMPARATIVE STUDY OF SEISMIC ANALYSIS OF REGULAR AND IRREGULAR STRUCTURE WITH AND WITHOUT POST-TENSIONED SLAB

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Abstract - *In this paper, seismic analysis is carried out on regular and irregular structures with and without post-tensioned slabs. Post-tensioned slab has been increased due to its ease, economy and it has more advantages over conventional type. Its is a challenging task for any structural engineer when an irregular structure or building to be designed with post tensioned slab are in a seismic zone. This thesis is to compare the seismic performance of such structure. Modelling of G+10 story building using ETABS and performing response spectrum analysis using said software. It has been observed that the displacement is higher in regular structure in comparison to the same structure with the use of PT slab. It also shows how irregular structures are affected by torsion.*

Key Words*: *Seismic, ETABS, Response spectrum analysis, and Torsion

1. INTRODUCTION

A sudden violent shaking of the ground, destroying the earth's crust is known as an earthquake. Structure collapse, tsunamis, fires, rock falls, landslides, and other secondary hazards can all result in fatalities during earthquakes. Structures kind, quality, and vibration are the key determinants of structural collapse intensity. The amount of fatalities is influenced by structural reaction, structure type, time (and season) of the earthquake, as well as rescue and relief. Construction typologies can often be categorized into three major categories: (a) earthquake loads, (b) gravity loads, and (c) (c) non-engineering. A high percentage of developing nations, including India, fall under these groups (b) and (c). Such architectural typologies result in significant human casualties during violent shaking.[1]

1.1 Aim and Objective

The aim of design is the achievement of an acceptable probability that structures being designed will perform satisfactorily in the software mentioned with the following objectives:

1. To perform response spectra analysis and get the responses of displacement.

2. To perform response spectra analysis and get the responses of story drift in each direction.

3. To analyze the torsional irregularity.

4. To differentiate the results under the same seismic parameters in irregular structures with and without post-tensioned slabs.

2. LITERATURE REVIEW

A state-of-the-art literature review is carried out as part of the present study. This chapter presents a brief summary of the literature review and all the studies about different types of structures and the parameters that will be used.

2.1 Types of Structures:

a) Regular structures: Regular structures are the ones that are in vertical configurations and have no significant discontinuities in the plan.

b) Irregular Structures: Irregular structures are the ones that have certain physical discontinuities either in the plan or in elevation or both which affect the performance of the structure subjected to lateral load.

c) The irregularity in building structures could be attributable to irregular mass, strength, and stiffness distributions along the building's height. The irregularity can be caused when a building is L shaped or T shaped, or when we have parking floors whose floor height is different from the others, or when we have amenities such as swimmimg pool on the middle floor or so as shown is fig 1. The study and design of such structures become more challenging when they are built in high seismic zones.

Different types of irregularity in building are:[2]

1] Mass irregularity irregularity

2] Stiffness irregularity

3] Geometric irregularity

4] In-plane irregularity

2.2 Post-tensioned slab:

Post-tensioned slabs offer the thinnest slab type, as concrete is worked to its strengths, mostly being kept in compression. Post-tensioned slabs use high-strength tensioned steel strands to compress the slabs, keeping the majority of concrete in compression. Material usages and cost of construction decreases when compared to reinforced concrete. It is provided on larger span areas.

The main purpose of this, to reduce gravity loads and avoid cracking issues. [4] In comparison to reinforced concrete,

- A considerable saving in concrete and steel
- Due to the participation of the entire concrete cross-section more thin and slender designs are possible.
- Smaller deflections compared to structural members with steel and reinforced concrete.
- Good crack behaviour and therefore better protection of the steel against corrosion.
- Almost unchanged serviceability even under considerable overload, since temporary cracks close again after the removal of overload. –
- High fatigue strength, since the amplitude of the stress changes in the prestressing steel under alternating loads are quite small. [4]..

Fig -1: Post-tensioned component

Figure 1, shows us the main components that are used while post tensioning. The left corner shows us the hydraulic jack that is used to create tension in the tendons. This jack is used to create tension which elongates the tendon. This elongation length is then noted which gives us an idea how much stress the tendons can take.

2.3 Seismic Analysis:

A Seismic examination is an instrument for the assessment of underlying reaction during the time spent planning earthquake designs as well as retrofitting weak existing constructions. On a fundamental level, the issue is troublesome because the underlying reaction to solid tremors is dynamic, nonlinear, and irregular. Each of the three attributes is surprising in primary designing, where the incredible greater part of issues are (or if nothing else can be enough approximated as) static, straight and deterministic.[5] Thusly, extraordinary abilities and information are required for a seismic plan, which a normal planner doesn't have. There are different types of methods in performing seismic analysis:

a) Equivalent Static Analysis

b) Non-Linear Static (Pushover Analysis)

c) Linear Dynamic (Response Spectrum)

d) Non- Linear Dynamic (Time History)

Virote boonyapinyo1, Nuttawut intaboot: Seismic capacity evaluation of post-tensioned concrete slab-column frame buildings by pushover analysis using SAP 2000. This paper presents a study of seismic analysis on building at Bangkok by the pushover analysis method. It was observed that the lateral capacity of the building can increase about 18% and 40% by applying the drop panel and shear wall. It was seen that nonlinear pushover analysis resulted in yielding and failure in slab column frame.

Shriraj S. Malvade, P.J. Salunke(2017): Analysis of Post-Tensioned Flat Slab by using SAFE. The paper focuses on modelling and carrying out a design on a post-tensioned slab using the SAFE. The analysis provided different ways on how the tendons can be placed in order to avoid torsion. It also shows how hyperstatic moments are affected.

S. Rossier,4 M. Ferrière, (2018): Nonlinear Time-History Analysis for Validation of the Displacement-Based Seismic Assessment of the RC Upper Bridge of a Dam: The paper centres around the nonlinear time-history investigations which were accomplished to check the precision of the outcomes acquired utilizing the relocation based technique. The primary qualities of the supported substantial upper extension are like those of traditional scaffolds. Notwithstanding, the wharves were worked with next to no support, and subsequently they will display shaking conduct if there should arise an occurrence of seismic tremor stacking. disappointment system. 20

3. METHODOLOGY:

1. Understanding of literature review.
2. Identifying the building plan and its design parameters
3. Modelling a regular and irregular structure in ETABS
4. Analysis of building using response spectrum
5. Modelling the same with post-tensioned slabs

6. Observation, Comparison, and Conclusion.

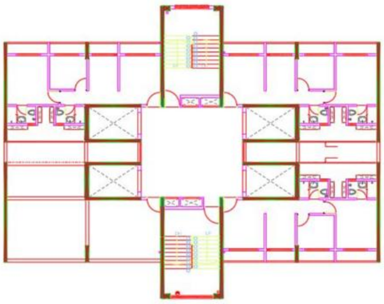


Figure shows us the architectural plan of the building that we have considered for our analysis.

3.1 Material Properties:

Table -1: Material properties of the structure

Specification	Concrete		Steel
	M35	M40	HYSD 500
E (Mpa)	29580.4	31622.78	200000
G (Mpa)	12325.17	13176.16	-
Density (kn/m^3)	25	25	78.50

Table -2: Material properties of the structure

Section	Grade	Dimension(mm)
Beam	M35, M40	230x750
Column	HYSD 500, M40	230x1250
Slab	M35	125
Wall	Brick	230
Shear Wall	M35, Shell thin	230

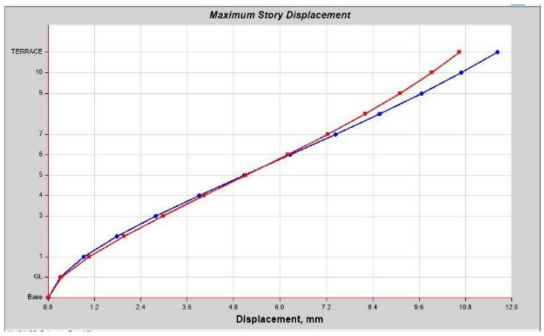
Table -3: Seismic Parameters

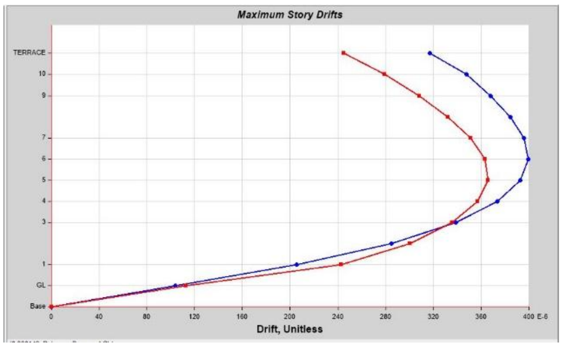
Parameters	RS_X	RS_Y
Load case type	Response spectrum	Response spectrum
Mass source	MS1	MS1
Load type	Acceleration	Acceleration
Load name	U1	U2
Scale factor	1000	1000
Load application	Displacement	Displacement

3. RESULTS:

STORY	DISPLACEMENT (mm)		DRIFT	CHECK
	X	Y		
Terrace	7.763	0.051	0.000182	Pass
10	7.227	0.046	0.000205	Pass
9	6.624	0.044	0.000224	Pass
8	5.966	0.041	0.000242	Pass
7	5.253	0.037	0.000257	Pass
6	4.492	0.032	0.000268	Pass
5	3.696	0.027	0.000272	Pass
4	2.886	0.023	0.000266	Pass
3	2.091	0.019	0.000248	Pass
2	1.348	0.016	0.000213	Pass
1	0.709	0.021	0.000155	Pass
Gl	0.245	0.03	0.000082	Pass

STORY	DISPLACEMENT (mm)		DRIFT	CHECK
	X	Y		
Terrace	11.619	10.644	0.000317	Pass
10	10.686	9.929	0.000348	Pass
9	9.66	9.113	0.000368	Pass
8	8.573	8.209	0.000384	Pass
7	7.436	7.231	0.000396	Pass
6	6.263	6.193	0.000399	Pass
5	5.076	5.118	0.000393	Pass
4	3.905	4.031	0.000374	Pass
3	2.789	2.967	0.000339	Pass
2	1.776	1.965	0.000285	Pass
1	0.923	1.065	0.000206	Pass
Gl	0.312	0.338	0.000104	Pass





4. CONCLUSION:

From the results obtained in this study following conclusions can be stated.

1. In this study for regular structures with the use of PT reduced the displacement of regular structures by 30 % in X and 28 % in Y direction.

2. The story drift check for all the structures passed the permissible story drift value as mentioned by the IS code 1893(Part 1) of 0.004.

3. It can be seen from figure 12 and 13 that with the use of PT in irregular structures the displacement and drift can be reduced to that in irregular structures without PT.

4. In regular structures due to symmetrical plan, there was no torsion found but in case of irregular structures, torsion was found which occurs when centre of mass and centre of rigidity does not coincide.

5. The provision of PT in structures can not only overcome gravity loads but can also reduce lateral displacements to some extent.

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