Seismic Retrofitting of a Structure with Soft Storey and Floating Column.

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Abstract: Tremors are called one in everything about preeminent erratic and annihilating of every cataclysmic event, be that as it may, the flighty idea of the incidence of those seismic tremors makes it inconvenient to hinder loss of living souls and annihilation of properties, if the constructions don't seem to be designed to oppose such seismic tremor powers. During this paper, a shot has been made to review set up irregularities specifically torsional irregularity and re-entrant corners within the frame structure. These inconsistencies square measure made according to IS 1893:2016 (part1) code. Irregular model and regular model were considered which were analyzed exploitation ETABS 2018 to see the unstable reaction of the structure. The models were analyzed exploitation static and dynamic ways, parameters thought-about being displacement, storey drift, torsional irregularity.

Keywords: Static analysis, Response spectrum analysis, Seismic response demands, irregularity, re-entrant, and ETABS.

1. INTRODUCTION

As of late, particularly in the fallout of the overwhelming Nepal earthquake on April 25, 2015, there has been a coordinated push across India to bring issues to light, especially practically speaking and instruction, about earthquake safe construction design. [1]The Bhuj earthquake, which happened on January 26, 2001, is a new illustration of this sort. Subsequently, there is an expanding interest in and interest for earthquake-safe building design. Strength and firmness standards are utilized to fabricate conventional Civil Engineering constructions. Since most of multi-story buildings are worked of RCC outline construction, it is basic to guarantee that the design is protected against sidelong loads brought about by wind and earthquakes. Seismic retrofitting might be done in an assortment of techniques and to differing degrees. The objective ought to be to guarantee that the design withstands all harm yet doesn't implode in case of a calamitous earthquake. [1]

This is normally utilized on the principal floor to oblige stopping or gathering anterooms. The in general
seismic base shear experienced by a building during an earthquake is dictated by the characteristic time of the earthquake, while the seismic power dissemination is controlled by the solidness and mass dispersion along the tallness. The floating column is an upward component that is upheld by a pillar yet has no premise. [2] The floating column goes about as a point load on the shaft, and the heap is moved to the columns underneath it through the bar. The floating column is utilized to give a compositional view and to make diverse site conditions. ETABS can be utilized to inspect it. Most designs in India cover the most doable space on a site inside the accessible principles, which requires the utilization of floating columns.

Retrofitting an open ground story outline by putting a RC divider in the open ground story gives the most strength and pliability. [2] The delicate story columns diffuse most of the energy produced by an earthquake. Plastic pivots are made at the finishes of columns in this technique, changing the delicate story into a system. The breakdown is inevitable in such a circumstance. [3]

2. METHODOLOGY

2.1 Response Spectrum Analysis

Response spectrum analysis is also known as linear dynamic statistical analysis method. This analysis generally done with the help of IS code for seismic analysis (7, 8). The IS code used for this study is IS 1893:2002 (Part 1). The values of seismic zone factor, soil type are taken from the tables which are from this IS 1893:2002 (Part 1) code. [5] The damping ratio is generally taken as 5% for this analysis is shown in the figure 1 below. The response spectrum Graph for medium soil condition is shown in the below graph. The graph is plotted between the Time period and Spectral acceleration coefficient (Sa/g). [4]

![Response spectrum for medium soil type for 5% damping](image)

Figure 1: Response spectrum for medium soil type for 5% damping

In this we need to discover the size of powers finished for instance X, Y and Z and after that see the repercussions for the structure. Mix techniques combine the going with:

1. Absolute - crest esteems are included [7]
2. Square foundation of the total of the squares (SRSS)
3. Complete quadratic blend (CQC) - a strategy that is a change on SRSS for firmly divided modes.

[7]

The output from the Response spectrum analysis is purely different from the linear dynamic analysis using the ground motions, in case of structure or building is irregular or high rise building this analysis of response is not accurate as we compared with other analysis and other method of analysis is needed, which is non linear static analysis or dynamic analysis (9).

2.2 Equivalent Static Analysis

This technique indicates a bunch of forces working on a construction to recreate the impact of earthquake ground movement, which is ordinarily determined by a seismic design reaction range. It is expected that the construction responds in its essential way. The building should be low-ascent and not contort impressively as the earth changes for this to be valid. [8] Given the characteristic recurrence of the construction, the reaction is perused from a design reaction range (either determined or characterized by the building code). Many building guidelines improve the helpfulness of this idea by adding parts to represent higher buildings with certain higher modes, just as unobtrusive levels of curving. Numerous codes utilize alteration factors that bring down the design pressing factors to represent impacts because of "yielding" of the construction (for example power decrease factors).

3. BUILDING SPECIFICATIONS AND MODELLING OF BUILDING

Statement of the project

In the present study, analysis of G+ 11 stories building in Zone V seismic zones is carried out in ETABS. [8]

Basic parameters considered for the analysis are:

| Utility of Buildings   | Residential Building |
|-----------------------|----------------------|
| No of Storey          | 12 Stories (G+11 Building) |
| Grade of concrete     | M40                  |
| Grade of Reinforcing steel | HYSD Fe500          |
| Type of construction  | RCC framed structure |
| Dimensions of beam    | 230mmX500mm, 230mmX400mm |
| Dimensions of column  | 500mmX500mm, 400mmX400mm |
| Thickness of slab     | 120mm                |
| Parameter                                  | Value                      |
|-------------------------------------------|----------------------------|
| Height of bottom storey                   | 4m                         |
| Height of remaining storey                | 3m                         |
| Building height                           | 34m                        |
| Live load                                 | 5 KN/m²                    |
| Dead Load                                 | 2 KN/m²                    |
| Density of concrete                       | 24 KN/m³                   |
| Loads considered in Buildings             | Dead load, live load, floor load, earthquake load, wind load |
| Seismic Zones                             | Zone V                     |
| Site Type                                 | II                         |
| Importance factor                         | 1.5                        |
| Response reduction factor                 | 5                          |
| Damping ratio                             | 5%                         |
| Structure class                           | B                          |
| Basic wind speed                          | 44 m/s                     |
| Method of analysis                        | Response spectrum analysis, Equivalent static analysis |
| Wind design code                          | IS 875: 1987 (Part 3)      |
| RCC design code                           | IS 456: 2000               |
| Steel design code                         | IS 800: 2007               |
| Earthquake design code                    | IS 1893: 2002 (Part 1)     |
Building models in ETABS Software:

Figure 2: Floating column Building

Figure 3: Soft Storey Building

Figure 2 and Figure 3 shows the modelling of the building using the ETabs software with floating column and soft storey respectively

4. RESULTS AND ANALYSIS

For Response Spectrum Analysis

Storey drift:

Comparison of drift values i.e $X$ values against storey number in $X$ direction shows similar results for both except after second storey in case of soft storey building. (Figure 4)
Comparison of drift values, i.e., \( Y \) values against storey number in \( Y \) direction shows similar results as shown in \( X \) direction. (Figure 5)

**Figure 4:** Comparison of storey drift in \( X \) direction

Storey Shear:

Comparison of Shear values against storey number in \( X \) direction shows shear values for soft storey building being higher than that for floating column building. (Figure 6)

**Figure 5:** Comparison of storey drift in \( Y \) direction

**Figure 6:** Comparison of shear \( V_x \)
Comparison of Shear values against storey number in $Y$ direction similar results as in $X$ direction. (Figure 7)

![Comparison of Shear Vy Values](image)

**Figure 7:** Comparison of shear Vy

**Building Torsion:**

Building torsion values shows almost same type of result in both the case of building as shown. (Figure 8)

![Comparison of Torsion T Values](image)

**Figure 8:** Comparison of Torsion

**Storey moment:**

Storey moment in $X$ direction shows increase in its value for soft storey building due to the presence of big opening being induced for the wide space. (Figure 9)
Figure 9: Comparison of moment Mx

It shows somewhat same results in the Y Direction as well. (Figure 10)

Figure 10: Comparison of moment My

Time period:

Time period values decreases from bottom to top storey and its values shows same results while at the top storey for both types of building. (Figure 11)
For Equivalent Static Analysis

Storey drift:

Comparison of drift values for both the types of building is shown for $X$ Direction. (Figure 12)

Comparison of drift values for both the types of building is shown for $Y$ Direction. (Figure 13)
Storey Shear:

Comparison of shear values for both the types of building is shown for $X$ Direction. (Figure 14)

![Comparison of Shear in Vx Values](image)

**Figure 14:** Comparison of shear Vx

Comparison of shear values for both the types of building is shown for $Y$ Direction. (Figure 15)

![Comparison of Shear Vy Values](image)

**Figure 15:** Comparison of shear Vy

Building Torsion:

Building torsional values are same for both case except at second and first storey it tends to decrease in soft storey building. (Figure 16)
Storey moment:

It shows almost same results for both type in $X$ direction. (Figure 17)

It shows same results as shown for the $X$ direction in $Y$ direction as well. (Figure 18)
Figure 18: Comparison of moment $M_y$

**Time period:**

It shows same results in both the types of analysis. (Figure 19)

Figure 19: Comparison of Time period

5. **CONCLUSION**

Following conclusions have been made on the basis of analysis and results:

1. Floating column structures perform ineffectively during earthquakes. [5]
2. It is notable that RC outline structures with open first stories perform seriously during critical earthquake shaking. For structures with delicate ground levels, the float and strength needs in the primary level columns are incredibly high. It is hard to supply such capacities in the main floor columns. Thus, it is obvious that such designs will work ineffectively during a huge earthquake. This perilous part of Indian RC outline buildings should be identified right once, and the necessary advances done to improve the building’s exhibition. [9]

3. The storey drift in X direction and Y direction has higher in floating column than soft storey structure in both RSA and ESA case.

4. The shear, bending, Torsion values has higher values for soft storey building than floating column building in case of RSA and it has almost same vales for both buildings in ESA analysis.

5. The time period values are decreases from node 1 to node 12 in both buildings

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