International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 13
September 2016

Static Linear and Non Linear (Pushover) Analysis of RC Building on Sloping Grounds on Medium Soils in Different Zones

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ABSTRACT:

The team of people involved in setting up the constructing services, including owner, architect, structural engineer, contractor and local authorities, make contributions to the overall planning, decision of structural procedure, and to its configuration. This may increasingly lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building. When such buildings are placed in a excessive seismic zone, the structural engineer's function becomes more challenging. Accordingly, the structural engineer desires to have a radical figuring out of the seismic response of irregular constructions. In up to date earlier, a couple of experiences have been applied to evaluate the response of irregular buildings. Earthquake field investigations again and again verify that irregular constructions endure extra harm than their standard counterparts. This is recognized in seismic design codes, and restrictions on abrupt changes in mass and stiffness are imposed. Irregularities in dimensions affect the distribution of stiffness, and in flip influence potential, whilst mass irregularities tend to impact the imposed demand. Elevation irregularities were determined to rationale story disasters because of non- uniform distribution of demand-tosupply ratios along the height. Plan irregularities, on the other hand, intent non-uniform demand-to-potential ratios amongst the columns within a single floor. The structure chosen for study is a 4, 5 storied commercial complicated constructing. The constructing is placed in seismic zone IV on a rock soil web site. Three dimensional mathematical items for the equal are generated in ETABS software. For all structural elements, M40 grade of concrete is used. The floor diaphragms are

assumed to be rigid. Seismic loads had been considered acting alongside either of the two predominant instructional materials. Using ETABS a4, 5 storey RC structure with average ground slope is chosen in between 0° and 25°and constructing that which produce less torsion outcome for setback and step-back with irregular configuration in horizontal and vertical direction is modeled and analyzed.

INTRODUCTION: The group of humans concerned in developing the constructing offerings, including owner, architect, structural engineer, contractor and local authorities, make a contribution to the total planning, choice of structural system, and to its configuration. This may increasingly more and more result in building constructions with irregular distributions in their mass, stiffness and force along the peak of constructing. When such structures are placed in a excessive seismic zone, the structural engineer's perform becomes tougher. Hence, the structural engineer desires to have an intensive figuring out of the seismic response of irregular constructions. In up to date previous, a couple of experiences have been utilized to assess the response of irregular buildings. Earthquake subject investigations over and over again verify that irregular constructions suffer further harm than their commonplace counterparts. This is well-known in seismic design codes, and restrictions on abrupt changes in mass and stiffness are imposed. Irregularities in dimensions affect the distribution of stiffness, and in flip have an effect on skills, while mass irregularities are inclined to have an effect on the imposed demand. Elevation irregularities were determined to rationale story failures when you consider that of non- uniform distribution of demand-tosupply ratios along the peak. Plan irregularities, on the other hand, intent non-uniform demand-to-competencies ratios amongst the columns inside a single ground. The structure chosen for be taught is a 4, 5 storied industrial difficult setting up. The establishing is positioned in seismic zone IV on a rock soil site. Three dimensional mathematical items for the equal are generated in ETABS program. For all structural elements, M40 grade of concrete is used. The floor diaphragms are assumed to be inflexible. Seismic loads had been considered appearing alongside either of the 2 predominant instructional materials. Using

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e-ISSN: 2348-795X
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ETABS a4, 5 storey RC constitution with typical floor slope is chosen in between 0° and 25°and establishing that which produce less torsion effect for setback and step-again with irregular configuration in horizontal and vertical direction is modeled and analyzed.

OBJECTIVES

The target of this work is to be trained the linear, non-linear habits and performance of building frame on sloping floor will depend on quite a lot of hill slopes and number of experiences. The target of be taught is as follows:

[1]. To gain knowledge of the variation of base shear, displacement, drifts with appreciate to version in more than a few hill slopes.

[2]. To study the target displacement in quite a lot of hilly slopes and finding the attitude that subjected to much less torsion and which is safe in increasing the height of building.

ANALYSIS METHODS

Static Analysis of Buildings Using Is 1893 (Part 1)- 2002

Design Seismic Base Shear- The total design lateral force or design seismic base shear (Vb) along any principal direction of the building shall be determined by the following expression VB= Ah W

Where Ah = Design horizontal seismic coefficient. W = Seismic weight of the building

Seismic Weight of building:

The seismic weight of each floor is its full useless load plus appropriate quantity of imposed load. Even as computing the seismic weight of each and every floor, the load of columns and partitions in any storey can be equally disbursed to the flooring above and below the storey. The seismic weight of the entire building is the sum of the seismic weights of all of the floors. Any weight supported in between the storey will probably be allotted to the floors above and below in inverse share to its distance from the floors.

Fundamental Natural Time Period: The fundamental natural time period (Ta) calculates from the expression from clause.7.6.1 of is 1893:2002 is as follows Ta = $0.09h/\sqrt{d}$ Where h is the height of thr building ,in meters,d base dimension of the building along the plinth level,in m, along the considered of the lateral force

Distribution of Design Force: The design base shear, VB computed above shall be distributed along the height of the building as per the following expression

Pushover Analysis After assigning all properties of the models, the displacement –controlled pushover analysis of the models are carried out. The models are pushed in monotonically increasing order until target displacement is reached or structure loses equilibrium. The program includes several built-in default hinge properties that are based on average values from ATC-40 for concrete members and average values from FEMA-273 for steel members. Locate the pushover hinges on model. ETABS provides hinge properties and recommends PMM hinges for columns and M3 hinges for beam as described in FEMA- 356. Define pushover load cases. IN ETABS more than one pushover load case can be run in the same analysis.

MODELLING AND EVALUATION: In the present be taught lateral load evaluation as per the seismic code for the naked frame and concrete Shear wall structure is applied and an effort is made to be taught the result of seismic masses on them and hence examine their seismic vulnerability via performing pushover analysis. The analysis is applied making use of Etabs evaluation package deal. Concrete body elements are labeled as beam and column frames. Columns and beams are modelled making use of three dimensional frame elements. Slabs are modelled as rigid diaphragms. The beam column joints are assumed to be rigid. Default hinge homes on hand in ETABS Nonlinear as per ATC- forty are assigned to the frame elements. Place of hinges in more than a few stages will also be obtained from pushover curve. Unique constructing add-ons are modelled as described under utilizing software, three detailed analyses are carried on eight storied building models on plain ground and on sloping ground, that are as follows:

- an identical Static analysis
- Response Spectrum evaluation

In this study six models are studied as described below Model 1: Building on Sloping ground (Bare Frame) - Building has no walls at all stories and is modelled as bare frame. However masses of the walls are included. In addition to wall masses the

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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other load like floor finish and imposed live load is added at each Storey. Model 2: Building on Sloping ground (Shear Wall at Centre) - Structural concrete shear wall (150mm) thick is provided in centre along longitudinal and transverse direction. Model 3: Building on Sloping ground (Shear Wall at Corner) - Structural concrete shear wall (150mm) thick is provided in corner. However masses of the walls are included. Model 4: Building on Plain Ground (Bare Frame) - Building has no walls at all stories and is modelled as bare frame. However masses of the walls are included. Model 5: Building on Plain Ground (Shear Wall at Centre) - Structural concrete shear wall (150mm) thick is provided in centre along longitudinal and transverse direction. Model 6: Building on Plain Ground (Shear Wall at Centre) - Structural concrete shear wall (150mm) thick is provided in corner. The plan layout of the reinforced concrete moment resisting frame of Eight Storey building is shown in Figures 1 to 3.In this study, the plan layout is deliberately kept same to study the effect of step backs. The Storey height is kept 3.5 m for all buildings. The building is considered to be located in the seismic zone-III and intended for office use. In the seismic weight calculations only 50% of the floor live load is considered. The input data given for the buildings is detailed below.

Example Description	
Number of Storey	: 08
Floor height	: 3.5 m
No of bay in X direction	: 5
No of bay in Y direction	: 5
Spacing in X direction	: 4 m
Spacing in Y direction	: 4 m
Beam sizes	: 300X450 mm
Column sizes	: 450X450 mm
Slab thickness	: 120 mm
Thickness of concrete Shear wall	: 150 mm
Live Load	: 4 kN/m^2
Floor Finish Load	: 1 kN/m^2
Concrete grade	: M30
Steel	: Fe415
Earthquake parameters	
Type of frame	: SMRF
Seismic zone	: III
Response Reduction Factor	: 5
Importance Factor	: 1

CONCLUSION

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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 The performance of reinforced concrete frames was investigated using the static linear analysis , pushover analysis .These are the conclusions drawn from the analysis

 The pushover analysis is a relatively simple way to explore the nonlinear behavior ofbuildings. The results obtained in terms of plastic hinges gave an insight into the real behavior of thestructures.

 Thus, the performance of pushover analysis depends upon of choice of material models included in the study.

 In step back and set back frames, it is observed that extreme left columns, which are on the higher side of the sloping ground and are short, are most affected. So, special attention is required while detailing and designing these short columns

. The number of plastic hinges formation in buildings on sloping ground are more in longitudinal direction as compared to transverse direction because of the effect of asymmetry along longitudinaldirection.

 The performance of the buildings on sloping ground suggests an increased vulnerability of the structure with formation of column hinges at base level and beam hinges at each storey level at performance point .

 For the buildings studied, it is found that the plastic hinges are less in case of buildings resting on sloping ground as the slope increases. Most of these elements are in the range of LS-CP and some of the elements lie in the range of C-D which indicates failure of elements lies in the range of collapse point increases the seismic vulnerability of the structure and such elements which are in LS-CP state requires retrofitting.

 From this study we observed that as the storey height increases the base shear and displacement also increases. But according to the performance of structure for slope at an angle of 21.58 degree it suggests up to four storey as the height increases it leads to collapse state

 As the height increases storey drifts alsoincreases.

 From this analysis the observations are as the angle of slope increases base shear increases and target displacement decreases.

 The base shear acts more in longitudinal direction than in transverse direction.

- From this we observed that for 16.32 degrees slope are safe upto 5- bay .But as the bay increases more no of hinges are to be formed and subjected to collapse region.
- In static linear analysis we observed that as the angle of slope increases storey shear decreases and base shear decreases.
- As the angle of slope increases displacement and drifts decreases.

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