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Seismic Analysis on Irregular Structures

[1]Prof.Tejaswini junghare , [2]Ravikumar Yadav, [3]Bhushan Rathod, [4]Pawan Ranbawale
[1]Professor, [2,3,4]Student, [1]Department of Civil Engineering, [1]JD College of Engineering and Management, Nagpur, Maharashtra, India.

Abstract : **This study observed that the behavior of seismic buildings on sloping ground differs from buildings resting on plain the real behavior of buildings on hill slope a 3-D analysis of the building is required. The dynamic response of the structure on hill slope has been examine. Most of the studies recognize that the buildings resting on hilly slope have higher displacement and Base shear compared to a building resting on plain ground.**

Keywords – Seismic Analysis, Structures, Buildings.

I. INTRODUCTION

Many of the engineers had taken efforts to study and enhance the earthquake resistance structure. As per IS:1893(part 2) 2002 there are four zones of earthquake in India that are zone I & II which are merged, zone III, zone IV and zone V. Due to increase in population and rapid urbanization it is necessary to build structures in a hilly region. Resulting in various important buildings such as RC framed, hospital, colleges, hostels and offices resting on hilly slopes. Due to the irregularities of structures the seismic forces are more server in hilly areas. Framed structures constructed on hill slope show different structural behavior than that on the plain ground. The behavior of building during the earthquake as per the distribution of mass, stiffness in both horizontal and vertical plane of the building. Generally on sloping ground step back and step back set back building configuration are used as shown in fig no1

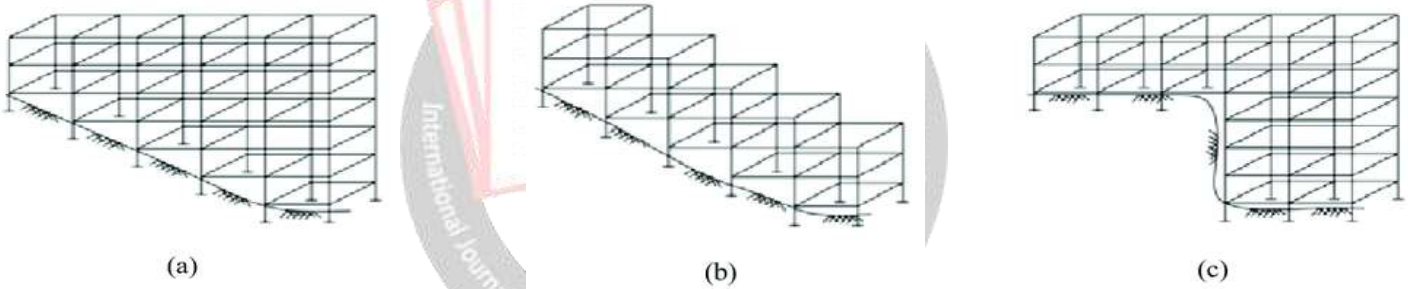

fig. 1. building configuration.

II. REVIEW OF PAPER BUILDINGS RESTING ON SLOPING GROUND

Likhitharadhyay, Praveen J, Sanjith, Ranjith.[1] studied unstable performance of buildings on hill slope. They enforced 3D house frame analysis to check dynamic response of the buildings, in terms of base shear and prime floor displacement. A constant quantity study was applied on thirty six buildings with 3 configurations as step back, step back set back and set back buildings settled in unstable zone IV. Considered seismic response of one method slope RC frame building with soft structure. During study they concentrated on the behavior of buildings set on sloping ground with and while not infill wall. Carried out pushover analysis on different kinds of structure i.e symmetric and asymmetric structures constructed on plain as well as sloping ground subjected to different types of loads. They considered different structures in plan symmetry and also asymmetry having different bay sizes in mutual direction. On sloping ground they considered a 5 and 6 storey building in which they have taken one storey above ground level which is situated at a slope of 27 degree with the horizontal. Following conclusions can be built from the analysis. The hilly area buildings possess relatively maximum displacement and shear forces which may give to critical situations than the horizontal ground. Base shear is maximum at 20^0 slope compared to another models. Base shear is maximum in X-direction related to Y-direction for sloping ground building. From the analysis, Mode duration is decrease with increase in slope angle. Mode period is directly proportion to the mass of the structure, if mass of the structure increases, then mode period also increases. From the analysis, if slope angle is increases storey displacement is decreases simultaneously. Displacement is maximum at the top story when related to bottom storeys in all other models along x and y-direction. if slope angle is increases storey displacement is decreases simultaneously. Acceleration is more in storey-11 when compared to storey-1 in all other models along x and y-direction.

Nagargoje and .Sable [2] studied seismic Analysis of Multi-Storey Building Resting on Flat Ground and Sloping Ground. They studied unstable performance of buildings on hill slope. They enforced 3D house frame analysis to find out dynamic response of the buildings, in terms of base shear and prime floor displacement. A constant quantity study was applied on thirty six buildings with three different configurations as step back, step back set back and

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set back buildings settled in unstable zone III. B.G.Biradar and S.S.Nalawade (2004) studied performance of hill buildings by considering story level up to eleven, but during this paper the study is applied by considering construction level starting from 4 to 15 (15.2 m to 52.6m). They found that the construction displacement of step back buildings is kind of high as related to step back –set back buildings,. They found that the bottom shear elicited in step back set back buildings is higher within they vary of sixty and 260% than set back building. They adopted step back set back buildings could also be favoured on sloping ground. Earthquake is considered to be one of the worst natural hazards which often turn into destruction causing a large amount of destruction and lose of human life. The effect of the earthquake varies upon An approximate method is presented for the analysis of multi-story asymmetric step back buildings. The method may be found useful at the stage of the preliminary design, where the decisions about the structural layout have to be taken prior to a full 3D dynamic analysis. Presently, the accuracy of this procedure is investigated in asymmetric tall buildings with a mass or stiffness irregularity. For the bents which are reduce at the level of the setback an almost formula is proposed and the results of the method are presented and compared with the definite data provided by the SAP2000 computer program for the case of 8-story buildings composed by frames, shear walls and coupled walls systems. The building consists of two uniform sub-structures: the base and the tower one with the corresponding heights. This response is keep in the inelastic phase, when the strength of the lateral load resisting bents is derived from a planar static analysis, as a consequence of the almost concurrent yielding of these bents. This is demonstrated in frequent 8-story setback buildings under a characteristic ground motion.

George Georgoussisa, Achilleas Tsompanosa and Triantafyllos Makarios.[3] Studied approximate seismic analysis of multi-storey buildings with mass and stiffness irregularities. An approximate method is presented for the analysis of multi-story asymmetric step back buildings. The method may be found useful at the stage of the preliminary design, where the decisions about the structural layout have to be taken prior to a full 3D dynamic analysis. Presently, the accuracy of this procedure is examined in asymmetric tall buildings with a mass or stiffness irregularity. For the bents which are reduce at the level of the setback an approximate formula is proposed and the results of the method are presented and compared with the definite data provided by the SAP2000 computer program for the case of 8-story buildings composed by frames, shear walls and coupled walls systems. The building consists of two uniform sub-structures: the base and the tower one with the corresponding heights. This response is keep in the inelastic phase, when the strength assignment of the lateral load resisting bents is derived from a planar static analysis, as a consequence of the almost concurrent yielding of these bents. This is demonstrated in frequent 8-story setback buildings under a characteristic ground motion. The codes require a full 3D dynamic analysis, even for low height building.

Zaid Mohammad, Abdul Baqi, Mohammed Arif.[4] studied seismic response of RC framed buildings resting on hill slopes. They considered eighteen analytical models with two different configuration i.e step back configuration and step back set back configuration at slope of 260. They carried seismic analysis by using equivalent static approach and response spectrum method in element code ETABS V9.0. the building configuration is located at zone V. They compared the building confurigation on the basis of seismic parameters such as fundamental time periods, maximum top storey displacement, storey shear, storey drift and column shear at ground level in each direction. They analyzed the building configuration with inter- storey height is taken 3m and foundation depth is 1.5m. The thickness of slab at all floors and considered as 125mm. The bays varying from 4 bays to 8 bays (6m each). From comparison they conclude that the step back set back building confurigation experience less torsion moment and seismic forces as compared with step back building due to less seismic weight of structure. Hence it can be stated that the step back set back building perform better that the step back building when subjected in seismic loads.

B.G.Birajdar, S.S. Nalawade[5] studied seismic performance of building resting on sloping ground. They performed seismic analysis on 24 RC framed buildings with three different configuration like step back building configuration and step back set back building configuration. The building is located at zone III and height of storey ranging from 4 to 11 storey (15.75m to 40.25 height) resting on sloping ground as well as on the plain ground. The analytical parameters are in the terms of base shear, fundamental time periods and top floor displacement. The building configuration is resting on the slope of 27^0 with horizontal. The foundation depth is 1.75m and hard strata. They used response spectrum method for analysis. They consider other parameters for seismic analysis like zone factor 0.16, importance factored 1.0, 5% damping and response reduction factor is 3.0, presuming SMRF. They conclude that the performance step back building during seismic excitation could prove more vulnerable than other configuration of buildings. The development of torsional moments in step back set back buildings is less than that in the step back s buildings. Hence step back set back buildings are more vulnerable than step back buildings against seismic ground motion. In step back buildings and set back set back buildings it is observed that the extreme left column at ground level which are shorter are worst affected. Special attention should be given to these columns design and detailing. Although the set back buildings on plain ground attracts less action forces as compared to step back set back buildings overall economic cost involved in leveling the sloping ground and other related issue needs to be studied in detail.

Mr.Achin Jain, Dr.Rakesh Patel [6] studied Analysis of building constructed on sloping ground for different types of soil. This research paper the seismic behavior of multi storey buildings on sloping ground considering soil-structure interaction. The analysis of a G+4 storey RCC building on varying slope angles. This analyses different soil condition. It has been detected of shorter height attract of that the footing columns are more forces, because of a large scale developed in their stiffness, which in turn increases the horizontal force (i.e. shear) and bending moment significantly. The present study emphasizes the need for proper analysis of structure resting on hilly slope for different conditions of soil like Soft Clay, Hard Clay,

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Dense Sand and Rock. As a result the hilly areas have marked effect on the buildings in terms of style, material and method of construction leading to popularity of structures in hilly regions. As a result of sloping profile, the different types of levels of such structures step back towards the hill slope and may also have setback also at the same time. Such construction in earthquake flat areas makes them to attract greater shear forces and torsion compared to normal construction. The process in which behavior of soil affects the motion of the structure and motion of the structure affects the behavior of soil is termed as soil-structure interaction. Buildings were analyzed for different soil conditions using STAAD Pro software idealized by equivalent springs. Finite element models considering various support conditions, solution schemes, structure heights, soil types and ways to account for soil pressure, were implemented. They considered a four storey building in which one storey is above ground level and it is constructed at a slope of 30 degree. The analytical horizontal forces and bending moment in footing increases with increase in ground slope. The critical bending moment in the column increases significantly for sloping ground 15^0 compared to plane ground. This research paper deals with comparative study of behavior of structures building frames with three geometrical configurations and different slope of ground.

Narayan kalsulkar [7] In this paper they both are studied the behavior of building during earthquake waves depending upon the distribution of mass and stiffness in horizontal as well as vertical planes. The aim of their study is providing an analytical approach for finding out horizontal and vertical displacement, storey drifts, time period, and base shear for a building which is resting on hilly areas. Main objective of their study are to give the effective configuration of building frame for both configuration of building, variation of base shear for both configuration, variations in time period with a respect to bays. They consider 6,8,10 stories for both configuration having different slopes, such as 16.32°, 21.58°, 26.56° and 31.56°. They consider lll Zone having zone factor 0.16 and importance factor 1. They analyzed the structure by using ETABS Software. They analyzed 48 models and compared in two model configuration which is step back and step back and set back frame. After analyzing and comparing they concluded that step back frames gives greater base shear as compared to step back set back frames. Step back building configuration give greater values of top storey displacement as compared with step back-set back frames.

Pandey A.D and prabhat kumar [8] studied seismic soil-structure interaction of buildings on hill slope static pushover analysis and response spectrum analysis on five building i.e they consider two step back-set back buildings and three step back buildings with different support conditions and they carries 27degree slope with horizontal which is not so falt and not so steep. They analysis the buildings with different soil conditions (hard, medium and soft soil) and idealized by equivalent springs. They consider 5percent damping for all modes of vibration. For ground acceleration they carried different direction to known response of building in all direction. The hinges formation always start from small columns and at last they reached to long columns. In that study it is found that response reduction factor decreases with increase in time period. But it is Hope that factor would be constant for a certain time period.

S. Monish, S. Karuna, [9] studied Effect of vertical irregularity in RC framed building in severe seismic zone performed the analysis on building which was an ordinary moment resisting frame of different irregular configurations in 20 storey with 3m height of each storey, located in seismic zone V. The irregularities were considered as per clause 7.1 of IS 1893:2002 code. Modelling and analysis were performed by ETABS software using static and dynamic method, with parameters like displacement, base shear and fundamental natural period. This analysis were then conclude that, due to shortening of column and reduction in stiffness, buildings on sloping ground found to be the most vulnerable among all the models, both dynamic and static methods were performed but result obtained from response spectrum analysis were more realistic hence Dynamic method of analysis were found to be more accurate than static method and the fundamental natural periods show that the code IS 1893:2002 doesn't consider the irregularity of the building.

Kalyanrao, Gude Ramakrishna[10] studied pushover Analysis of Sloping Ground RC Buildings states that, as This paper presents an overview performance of sloping ground building subjected to Pushover analysis as assessed in ATC-40 and FEMA-356.The analysis is carried out by Pushover analysis using ETABS software. The dynamic properties like Base shear, Roof displacement, Mode shapes, Fundamental natural periods, Ductility ratio and Hinge status induced in the building models have been studied to check performance of the building. This analysis conclude with points, the maximum base shear is induced in Setback-Step back building. After the pushover analysis the base shear obtained at a point is more as compared to design base shear. It is found that for all buildings the roof displacement should be within permissible limit. Step back-Setback building may be favored on sloping ground which increases the performance and has less weak elements. When stiffness of the building increases the fundamental natural period get decreases that leads to increase in base shear.

Rahul Ghosh, Rama Debbarma [11] studied effect of slope angle variation on the structure resting on hilly region considering soil-structure interaction. Structures resting on sloping ground are highly sensitive to earthquake due to irregularities in plan and elevation. Strong earthquakes strike frequently at different parts of the world causing damage to life and all kind of structure. The unavailability of plain ground in hilly region compels for construction activity on hilly slopes. It is noticed that rise of the slope, the fundamental time period of the models gets decreases. In this study all the models are analyzed in linear static method which is known as ESFM. Pushover analysis is nothing but linear time history analysis method and NLSAM. Torsional erect arises from the eccentricity in a building, when the center of mass of the building does not coincide with its center of rigidity. The intersection point of capacity curves of the structure and displacement demand curves is known as the performance point. So, this paper reflects the adverse effect of slope angle increment on the structure resting on sloping ground and recommend taking special care during the designs of columns on the higher

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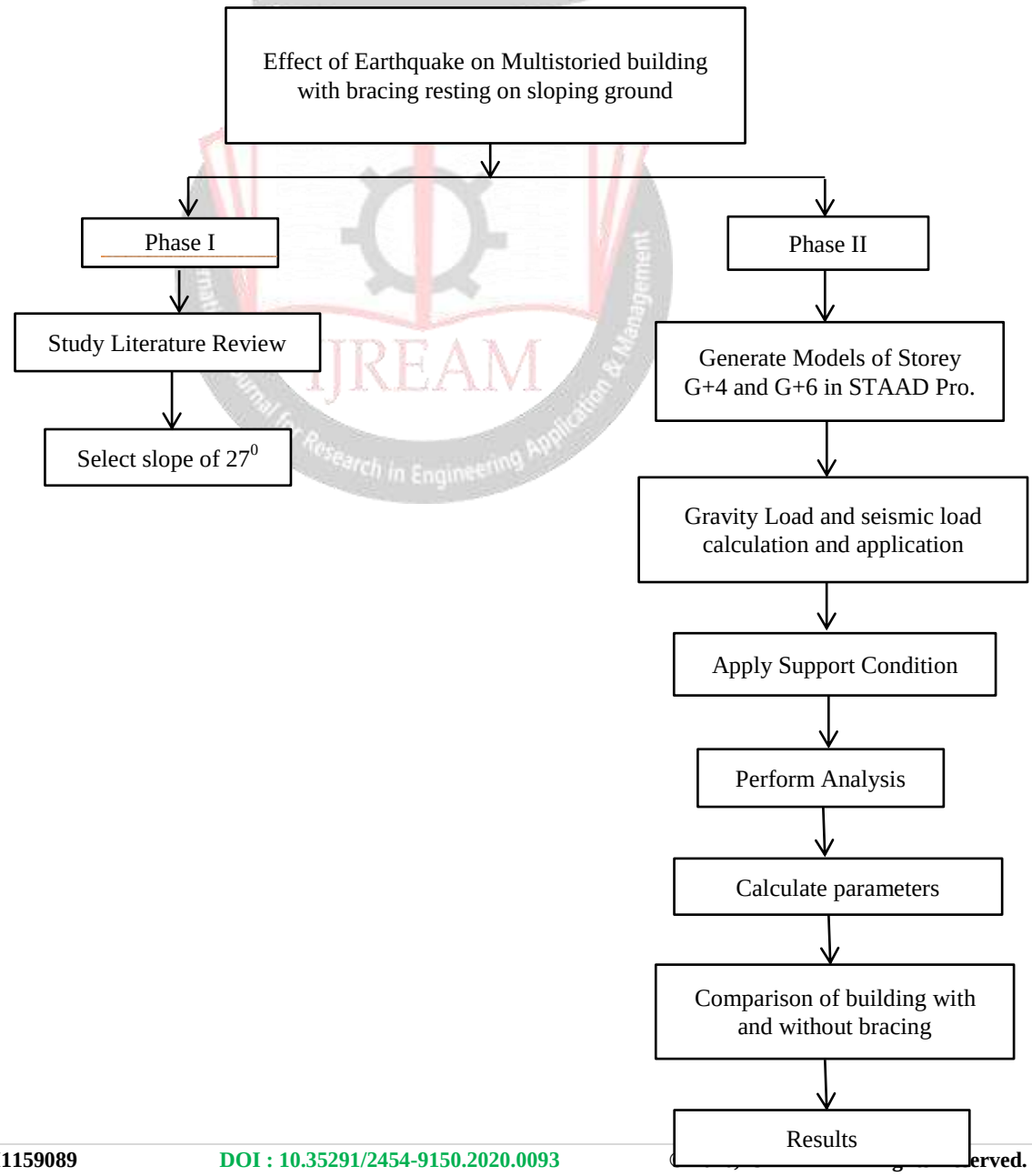
level of the slope of structures. These limitations are included in the future scope of the work.

Miss .Chaitrali Arvind Deshpande, Prof P.M. Mohite[12] studied effect sloping ground on step back & set back configuration of RCC frame building, define multi-storied building with storey height 3.1m resting on sloping ground. Different slope consider for the analysis were 26 28 30 degree in Zone III and for Special Moment Resisting Frame. He said that the analysis of actual practiced building with step back and step back-setback configurations and ground conditions, i.e. sloping ground and levelled ground were performed as per IS1893-2000 by using response spectrum method in STAAD Pro software. This study indicates that for both conditions i.e. sloping and levelled ground, during earthquake step back-setback building gives effective response.

Ashwani Kumar, Push Plata [13] studied building regulations for hill towns of India. Development of pressure on given locations in the Himalayan areas has increased during the last few decades due to urbanization, population increase, and high inflow of tourists. These given locations are changed into hill towns, Hill locality are the most difficult, yet most curious and challenging area, to carry out any development work as development in Hilly regions is constrained by difficult area, hilly gradients, complex geological structure, climatic conditions and rich flora. Due to increase in population heavy pressure on the housing and existing infrastructural facilities is exerted which leads to migration from the surrounding region as well as a high influx of tourists which also leads to construction of multi-storeyed buildings in hill towns for residential, office and commercial purposes. Hills stations are most of the located in geological conscious zones. Hill towns are susceptible to different types of natural hazards like landslides, earthquakes, floods, cloudburst, and fire. Most of the buildings are constructed or being constructed without adhering to safety provisions against natural hazards and are susceptible to heavy damage during the event of any natural calamity. Many of the issues of existing development in hill towns are due to the absence of appropriate building regulation, enforcement of inappropriate building regulations or non-compliance of existing building regulations.

III. METHODOLOGY



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CONCLUSION

As per the above discussion following conclusions are made

[1] The step back buildings attracts more displacement, shear forces mare amount of top storey displacement as compared to step back set back buildings. Step back set buildings prove to be more vulnerable than the step back building during earthquake.

[2] It is observed that the bottom shear obtain in step back set back buildings is more than that of setback buildings. Thus step back set back buildings are more beneficial on sloping ground.

[3] Short column attract more seismic forces and more torsional moment and are badly affected during earthquake.

[4] They conclude that the performance step back building during seismic excitation could prove more vulnerable than other configuration of buildings.

[5] The performance of step back buildings during earthquake action could prove more attracted than the other configurations.

The step back set back buildings configuration perform more superior that that of step back buildings during earthquake.

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