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Literature Review on the Development of Forces and Displacements under Seismic Loading in Structure with Offsets

Adhika Pimparkar[1], Mandar Joshi[2]
[1, 2]Department of Civil Engineering, Pankaj Laddhad Institute of Technology and Management studies, Buldhana- 443001. Maharashtra State, India.

Abstract: Tall structures are being constructed with offsets in horizontal also as vertical directions to realize architectural beauty, architectural complexities became normal practice resulting in development of horizontal and vertical offsets within the structures and making them vulnerable from seismic safety point of view. However creations of those of offset are leading to uneven increase of forces and displacements in various columns. there's have to evaluate the rise within the forces and displacement in various columns placed at critical locations within the structure. The IS 1893-2002 Part-I is revised with the many changes in various clauses, especially in relevance the offsets in buildings. it's observed that the introduction of multiple offset ands in symmetric plan may result in erratic increase of torsional moments and shear forces and displacement within the columns at various column locations, it's advisable to critically evaluate the column forces for columns near and off from the offsets to form the structures safe under seismic loading. Offset in structures are unavoidable from aesthetic point of view, however careful analysis with full understanding of consequences is important from seismic safety point of view.
Keywords: Seismic Loading, Offset, Tall Structure, Torsion

I. INTRODUCTION

A. Architects have started giving more Overview

emphasis on structural elevation and have started bringing more offsets within the plan also as in elevation. it's a well known incontrovertible fact that creation of offsets in elevation may end in improper transfer of inertial force to the bottom. These sorts of structures are normally treated undesirable in areas with severe seismic activities. Proper design considerations and adequate safety measures may result in seismically safe structure with various offsets in plan and elevation. there's great got to critically analyze the event of forces and displacement thanks to various offsets at various column locations and compare them with regular structures. Earthquakes are the foremost unpredictable and devastating of all-natural disasters, which are very difficult to save lots of over engineering properties and life, against it. Hence to beat these issues we'd like to spot the seismic performance in order that can save as many lives as possible. The behavior of a building during an earthquake depends on several factors, stiffness, adequate lateral strength and ductility, simple and regular configurations. The buildings with regular geometry and uniformly distributed mass and stiffness in plan also as in elevation suffer much less damage compared to irregular configurations. But nowadays need and demand of the newest generation and growing population has made the architects or engineers inevitable towards planning of irregular configurations. Vertical irregularities are one among the main reasons of failures of structures during earthquakes. In IS 1893-2002 define the rules associated with various sorts of irregularity.

B. Study of Codal Provision

For design of structures with offsets, IS 1893-2002 standard definiens specific guidelines by introducing the offset on the structures through various types of irregularities. The guidelines are presented below:
Important clause related to irregularity in is 1893-2002

1) *Plan irregularity*
   a) *Torsion Irregularity:* "To be considered when floor diaphragms are rigid in their own plan in relation to the vertical structural elements that resist the lateral forces. Torsional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure".
   b) *Re-entrant Corners:* "Plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond there-entrant corner are greater than 15 percent of its plan dimension in the given direction".
2) *Vertical Irregularity:* "Vertical geometric irregularity shall be considered to exist where the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey".

II. LITERATURE REVIEW

KeyvanRamin, Foroud Mehrabpour, (26 November 2013)[1].“In this paper the disorders originated from architectural design in buildings, show in different forms. Due to level difference form a slope which affect the short column phenomenon. The great stiffness of short columns it enables to absorb large amounts of structural energy. Earthquake regulations to this phenomenon necessitates paying further attention to it. On this basis, the present study employed experimental modelling and numerical modelling for a four-story reinforced concrete building that involves the analysis of simple 2-D frames of varying floor heights and varying number of bays using a very popular software tool STAAD Pro on both a sloping and a flat lot. Also Sap2000 software had been used to show that the displacement of floors is greater for a flat lot building than a sloping lot building. However, the increase in shear was found to be quite greater in short columns compared to common ones and an enormous moment should be tolerated by sloping lot structures. The greater stiffness of the structure was also revealed by non-linear static (Push-Over) analysis. According to the results, short column are required to have more resistant sections and are suggested to be reinforced with more bars. In addition, more steel should be used as stirrups than as longitudinal bars. Also for existing structures, shear capacity of short columns should be retrofitted by FRP, Steel Jacket or other materials”.

Yasser Alashker, Sohaib Nazar, Mohamed Ismaiel, (22 May 2015)[2],“The behavior of a building during earthquakes depends on its overall shape, size and geometry.Conventional approach to earthquake resistant design of buildings depends upon providing the building with strength, stiffness and inelastic deformation capacity which are great enough to withstand a given level of earthquake-generated force. This is generally accomplished through theselection of an appropriate building configuration and careful detailing of structural members.In this research, nonlinear pushover analysis has been used to evaluate the seismic performance of three buildings with three different plans having same area and height. This method determines the base shear capacity of the building and performance level of each part of building under varying intensity of seismic force. The results of effects of different plan on seismic response of buildings have been presented in terms of displacement, base shear and plastic hinge pattern”.

Milind V. Mohod, (September 2015)[3]. “Earthquake is a very important aspect when designing structures. In this paper presents effects of plan and shape configuration on irregular shaped structures. Buildings with irregular geometry respond differently against seismic action. Plan geometry is the parameter which decides its performance against different loading conditions. The effect of irregularity (plan and shape) on structure have been carried out by using structural analysis software STAAD Pro. V8i. There are several factors which affect the behaviour of building from which storey drift and lateral displacement play an important role in understanding the behaviour of structure. Results are expressed in form of graphs and bar charts. It has been observed from the research that simple plan and configuration must be adopted at the planning stage to minimize the effect of earthquake”.

Shaikh Sameer J., S.B. Shinde, (September 2016)[4].“The present paper attempts to investigate the proportional distribution of lateral forces evolved through seismic action in each storey level due to changes in stiffness of frame on vertically irregular frame. As per the Bureau of Indian Standard (BIS) 1893:2002 (part1) provisions, a G+10 vertically irregular building is modelled as a simplified lump mass model for the analysis with stiffness irregularity at ground floor. To response parameters like story drift, story deflection and story shear of structure under seismic force under the linear static & dynamic analysis is studied. This analysis shows focuses on the base shear carrying capacity of a structure and performance level of structure under sever zone of India. The result remarks the conclusion that, a building structure with stiffness irregularity provides instability and attracts huge storey shear. A proportionate amount of stiffness is advantageous to control over the storey and base shear. The soft computing tool and commercial software CSI-ETABS is used for analysis”.

Shaikh Abdul Aijaj Abdul Rahman, GirishDeshmukh,(August 2013)[5]. “The present paper attempts to investigate the proportional distribution of lateral forces evolved through seismic action in each storey level due to changes in stiffness of frame on vertically irregular frame. As per the Bureau of Indian Standard (BIS) 1893:2002(part1) provisions, a G+10 vertically irregular building is modelled as an simplified lump mass model for the analysis with stiffness irregularity at fourth floor. To response parameters like story drift, story deflection and story shear of structure under seismic force under the linear static & dynamic analysis is studied. This analysis shows focuses on the base shear carrying capacity of a structure and performance level of structure under severer zone of India. The result remarks the conclusion that, a building structure with stiffness irregularity provides instability and attracts huge storey shear. A proportion at amount of stiffness is advantageous to control over the storey and base shear. The soft computing tool and commercial software CSI-ETABS (version 9.7) is used for modelling and analysis”.

Devesh P. Soni, And Bharat B. Mistry, (December2006)[6]. “This study summarizes state-of-the-art knowledge in the seismic response of vertically irregular building frames. Criteria defining vertical irregularity as per the current building codes have been discussed. A review of studies on the seismic behaviour of vertically irregular structures along with their findings has been presented.

It is observed that building codes provide criteria to classify the vertically irregular structures and suggest dynamic analysis to arrive at design lateral forces. Most of the studies agree on the increase in drift demand in the tower portion of set-back structures and on the increase in seismic demand for buildings with discontinuous distributions in mass, stiffness, and strength. The largest seismic demand is found for the combined-stiffness-and-strength irregularity".

AbulHasnat , M Rifat Ibtesham Rahim, (December – 2013)[7]. "In this paper, response of a 15-storeyed frame to lateral loads is studied for stiffness and vertical irregularities. The proportional distribution of lateral forces evolved through seismic action and wind load also in each storey level due to changes in stiffness of frame on irregular frame is analysed. Analysis output are focused on mainly two basic points – storey drift and displacement under the action of load combination prescribed in Bangladesh National Building Code (BNBC) -1993. In BNBC, different kind's of irregularities are defined. In this paper, definitions according to BNBC are followed and analysis was carried out using CSI-ETABS 9 software. On the basis of analysis, some outlines are mentioned regarding safety and safe construction of irregular structure thus to reduce earthquake hazard".

Gaurav Joshi, K.K. Pathak And Saleem Akhtar, (December 2013)[8]. "In this study, seismic analysis of soft storey building frames have been carried out considering 3 building plans, 15 soft storeys cases and 20 load combinations. Soft storeys have been created by varying the floor heights and effect of infill is ignored. In this way, total 45 frames are analysed. STAAD.pro software has been used for analysis purpose. Results are collected in terms of max. Moment, max. Storey displacements, max. Shear force, max. Axial force and max. Drift, which are critically analysed to quantify the effects of various parameters".

Mr.Chetan Kumar, Mr. Nitinkumar, Er. T.N. Panday, Er. Bharat Phulwari, (2017)[9]."This study presents the design code perspective of this building category. Almost all the major international design codes recommend dynamic analysis for design of setback buildings with scaled up base shear corresponding to the fundamental period as per the code specified empirical formula. However, the empirical equations of fundamental period given in these codes are a function of building height, which is ambiguous for a setback building. It has been seen from the analysis that the fundamental period of a setback building changes when the configuration of the building changes, even if the overall height remains the same.

Based on modal analysis of 90 setback buildings with varying irregularity and height, the goal of this research is to investigate the accuracy of existing code-based equations for estimation of the fundamental period of setback buildings and provide suggestions to improve theiraccuracy. This study shows that it is difficult to quantify the irregularity in a setback building with any single parameter. Also, this study indicates that there is very poor correlation between fundamental periods of three dimensional buildings with any of the parameters used to define the setback irregularity by the previous researchers or design codes. The way design codes define setback irregularity by only geometry is found to be not adequate. Period of setback buildings are found to be always less than that of similar regular building".

Milind V. Mohod, Nikita A. Karwa (September 2014)[10]. "In this paper to study and specify some improvements in codal provisions for understanding the behaviour of setback buildings. Reference structure results were adopted for validation of results obtained from all these models, which helped us to reach the desired output of the task. Nodal displacement and storey drift criteria was considered for ascertaining the optimum value of critical setback ratios. The optimum value of setback ratio came out to be RA=75% and RH=6/5, where the nodal displacement and storey drift values are affecting structure in negligible amount as in comparison to other setback ratio values. Hence, as we go through seismic code, the revision of seismic codes provisions for geometric vertical irregularities seems to be essential to stipulate more restrictive limits or apply more accurate analytical procedures to predict the seismic performance of setback structures under the seismic excitations, especially for structures with critical setback ratios".

ImaMuljatia, Amelinda Kusumaa, Fonny Hindartoa, (2015)[11]. "This study will observe the effect of out-of-plane offset of frame in a concrete regular MRF designed using DDBD method for two different earthquake level. Nonlinear time history analysis is used to verify the structural performance based on three parameters: story drift, damage indices and structural failure mechanism. The offset frame is assumed to be in-plane with the adjacent frame, the existence of offset is ignored, and the structure is designed as a regular MRF.

The study shows that the main structural problem arises from the beams at the offset area due to high shear demand. DDBD procedure enable to adjust the ductility demand of these beams in order to improve the structural performance without involving design repetition as usually done in traditional seismic resistant design. In conclusion, DDBD performed well in predicting the seismic demands of the MRF system with out-of-plane offset of frame. The existence of offset frames in MRF system can be ignored during the design process as long as the ductility demandsof beams at the offset area is well adjusted".

III.CONCLUSIONS

Literature review on the development of forces and displacements under seismic loading in structure with offsets is studied. This study can be further used for the study of the behaviour of building during earthquake by considering overall shape, size and geometry. To understand development of forces and displacements in structures with offsets and compare them with regular structures.To identify critical locations such as torsion, moments, shear etc. developed in structures due to offsets. To determine various factors which affects to the RC structure originate due to vertical irregularity such as lateral forces, displacements, torsion, bending moments, time period etc.

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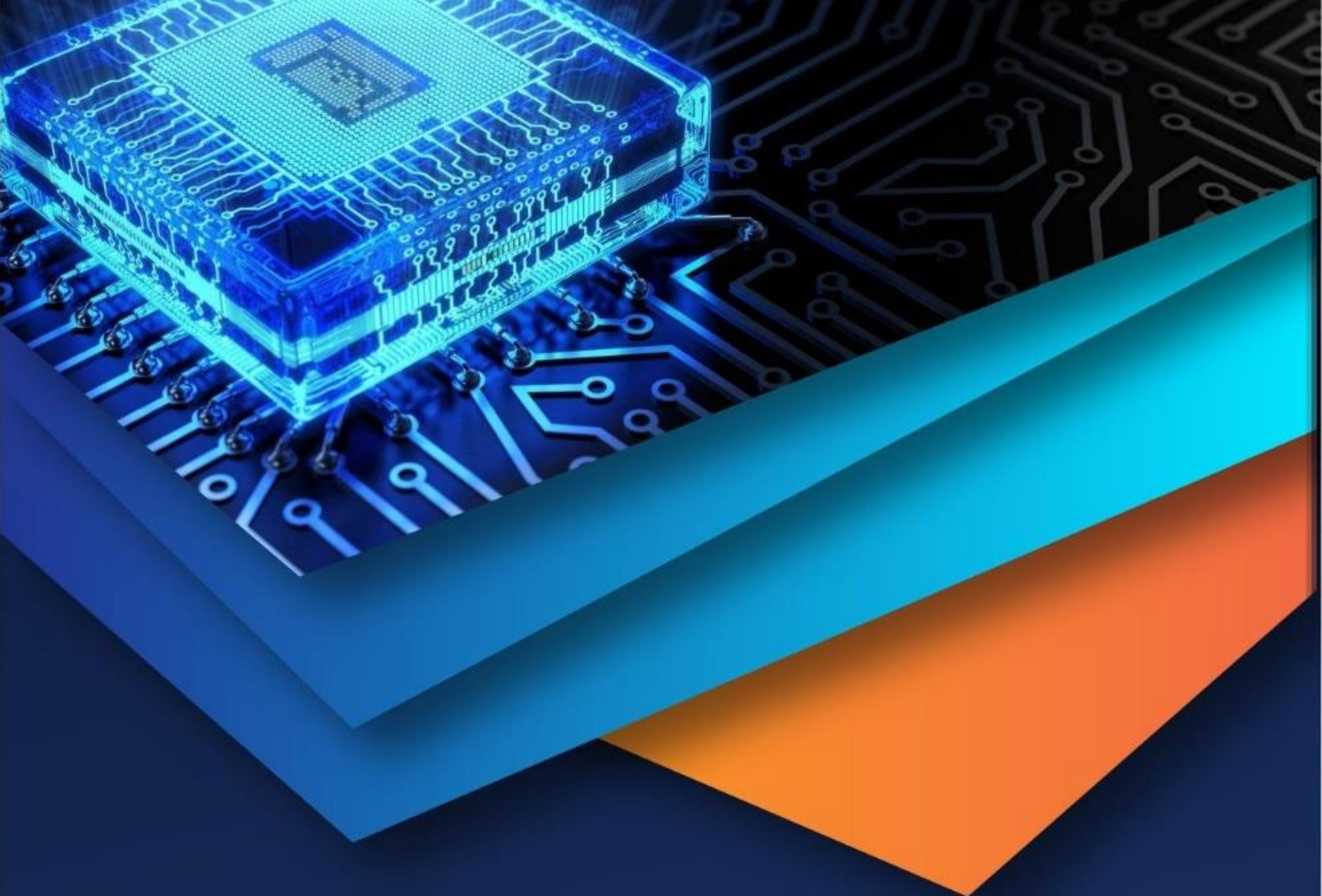

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