International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 5 ǁ 2022 ǁ PP. 41-46

Review Paper on Analysis of RCC Building with Soft Story Using ETABS.

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ABSTRACT: *Earthquake is the most challenging force that affects the buildings and other structures. The most affected type of structure is the building with soft stories. The soft storey located in the lower part of the high rise building especially the ground storey is undesirable as it attracts severely large seismic forces. At the same time, the soft storey located in the upper part of the high-rise building does not significantly affect the stability of the building. The building in which the ground storey consists of open space for parking area is known as stilt building and the parking storey is called as stilt floor or soft-storey. When sudden change of stiffness takes place along the building height, the storey in which the drastic reduction of stiffness is observed is known as soft storey. The building with soft storey is analysed using softwares like E-tabs, Staad-Pro and SAP 2000, and by methods such as time history analysis, response spectrum analysis and pushover analysis. In this proposed paper, we are going to study the literature using the previous researches for further analysis and design of multi-storey building with multiple soft stories*

Key words: *soft story analysis, E-tabs, Staad-Pro, SAP2000, time history analysis, response spectrum analysis, pushover analysis.*

Date of Submission: 01-05-2022 Date of acceptance: 12-05-2022

I. REVIEW OF LITERATURE:

1. Adrian Fredrick C. Dyaa, Andres Winston C. Oretaaa (2015)

In the study, it is assumed that the properties and number of structural members for each story is constant. Thus, soft stories may be defined by simply determining the height of the stories. The study is also limited to a single soft story at the first story. The severity of the soft story is varied by increasing the height of the soft story. A static pushover analysis is utilized to determine the performance of the building under different irregularity conditions. The output of the study may be used to improve existing level 1 seismic risk assessments. Due to the limitations of a static pushover analysis, the study only covers low-rise buildings as permitted by the NSCP. Though it is recognized that a dynamic time history is more suitable, a pushover analysis is sufficient due to the preliminary assessment nature of the objective. The study has found that one of the primary concerns in vertical irregularities is the localization of seismic demand. For soft story buildings, the concentration of seismic demand is where the soft story is located. Data from the pushover analysis is translated into score modifiers for the varying soft story severity which may be used for preliminary risk assessment tools.

2. F. Hejazi1 S. Jilani,, J. Noorzaei, C. Y. Chieng1, M. S. Jaafar, A. A. Abang Ali (2011)

in this paper occurring of soft at the lower level of high-rise buildings subjected to earthquake has been studied. Also has been tried to investigate on adding of bracing in various arrangements to structure in order to reduce soft story effect on seismic response of building. It is lead to assess the vulnerability level of existing multi-storied buildings so that they can be retrofitted to possess the minimum requirements. This will help in minimizing the impending damages and catastrophes.

3. Johneo Pasi, Avik Samanta (2020)

In this study, different types of energy dissipation devices, which include lower toggle bracing, double-bracing fluid viscous damper, single-bracing fluid viscous damper and single-bracing friction damper, and traditional infill wall are implemented in a 12 storied soft-storey building to assess their influences on reduction of building's responses during seismic events. These retrofitted buildings are analysed bi-directionally with various ground motion time history of Kolkata region, India. It is seen that energy dissipation devices proved to be better than traditional infill wall due to the fact that the devices enhance the damping capacity as well as stiffness strengthening to the building while traditional infill wall enhances only stiffness strengthening to the building.

4. Md Khairuzzaman, Md Zahid Hasan Sabuz, Muhammad Faizal (2021)

Their aim to study the problem using some economical techniques like infill masonry wall or proper bracing or retrofitting of building. Proper placement of bracing in different position is used to reduce soft story impact.

5. Shubham Velani, Kuldeep R Dabhekar, Prashant Y Pawade, Isha P khedikar (2021)

During their research analysis, a shot has been made to review set up irregularities specifically torsional irregularity and re-entrant corners within the framed structure. These inconsistencies were measured according to IS 1893:2016 (part1) code. Irregular model and regular model were considered which were analyzed in ETABS 2018 to see the unstable reaction of the structure. The models were analyzed in static and dynamic ways, parameters thought about were displacement, storey drift, torsional irregularity.

1. Mr. Prathamesh Sonawane, Dr. M. P. Wagh (2021)

In this research work, the effort has been made to investigate the effect of shear wall and structural wall on lateral displacement and base shear in RCC frames. RCC frame with G+13 is considered, one with soft storey and other with normal building in L-shape.

Based on the time history analysis, it was found that the placement of shear wall at the corners of structure symmetrically gives the better performance to reduce the lateral displacement. The pushover analysis of the R.C.C. building frame is carried out by structural analysis and design software ETABS.

2. R. Suresh, Dr. K. Narasimhulu (2017)

The objective their study is to check the applicability of the multiplication factor of 2.5 within the seismic analysis of a medium rise open ground storey building. A reinforced concrete framed structure (G+9) with open ground strorey, placed in Bhuj (seismic zone-V) is considered for this study. This building is analyzed for two different cases using response spectrum analysis method viz. (a) considering infill strength and stiffness (open ground storey), (b) Not considering infill strength and stiffness (bare frame). Infill Stiffness was created in ETABS by using equivalent diagonal strut approach. Analysis is carried out for these models and results were compared.

3. Misam Abidi, Mangulkar Madhuri. N. (2012)

They have highlighted the importance of immediate measures to prevent the indiscriminate use of soft first story in buildings, which are designed without regards to the increased displacement, ductility and force demands in the first story and this paper argues the importance of novel design approach which has an advantage of interaction between rigid frames and shear walls. A combination of the two structural components leads to a highly efficient system, in which the shear wall resists the majority of the lateral loads in the lower portion of the building, and the frame supports the majority of the lateral loads in the upper portion of the building.

4. Ravi Kanitkar, Vasant Kanitkar (2004)

The Bureau of Indian Standards has recently revised the provisions for the earthquake resistant design of structures in the IS 1893: 2002 criteria. Among other revisions, it has specifically addressed buildings with soft storey conditions (e.g. stilt buildings) by specifying increased design forces for the beams and columns of the soft storey. The authors have carried out elastic and inelastic analyses of a typical 5-storey residential stilt building with the intent of reviewing the new provisions. This paper describes the results of said analyses. In addition, the paper briefly discusses the validity of the new provisions and pinpoints areas requiring further investigation.

5. M. R. Maheri (1997)

In this paper the use of steel bracing in concrete-framed structures is investigated. The investigation is carried out through a series of tests conducted on a number of model frames. The object of the tests was to determine the degree of effectiveness of different diagonal bracing arrangements to increase the in-plane shear strength of the concrete frame and to observe the relative behaviour of tension and compression braces. The important question of the proper connections between the steel braces and the concrete frame is also considered. The test results indicate a considerable increase in the in-plane strength of the frame due to steel bracing. As an overall conclusion it is noted that, with proper connection between the brace and the frame, the steel bracing could be a viable alternative or supplement to shear walls in concrete framed buildings in seismic areas.

6. Mahapara Firdous,Sakshi Gupta (2017)

Their research work reviews the past studies and aims to find out how does orientation of columns and soft storey affects the seismic parameters such as deflection and time period. The study concludes that the soft storeys are to be provided in upper stories and combined effect of soft storey and column orientation is to be studied by means of software aid to prevent failure of building during earthquakes.

7. Mehmet Inel 1 and Hayri B Ozmen (2008)

This study investigates soft story behavior due to increased story height, lack of infill amount at ground story and existence of both cases using nonlinear static and

dynamic response history analyses for mid-rise reinforced concrete buildings. Displacement capacities at Immediate Occupancy, Life Safety and Collapse Prevention performance levels and story drift demands of the regular and soft story models are determined. Soft story behavior due to change in story height and/or infill

amount is evaluated in view of these displacement capacities, drift demands and structural behaviour. It is observed that, soft story due to infill walls may be as damaging as soft story due to increased story height.

8. Rezarta Uruci1, Huseyin Bilgin1 (2016)

The soft story effect under seismic loads in low and mid-rise buildings of Albanian construction practice was considered. In order to get the effect of soft story irregularity in RC buildings, several number of nonlinear static (Pushover) analyses are done for regular frames, frames with soft story because of higher height and lack of masonry infill walls in ground story or because of the presence of both cases for the two types of structures, three and six story frames representing low and mid-rise buildings respectively. The analysis has been performed by ETABS software. The results of the analysis indicate that low and mid-rise structures with soft story irregularity due to absence of infill walls and higher height of ground story are more vulnerable during earthquakes.

9. Pranamee Goswami, Tajmina Akhtar, Manas Pratim Das, Rishikesh Duarah (2020)

They have presented results from an extensive study investigating the seismic performance of soft storey building modelled in SAP2000. The infills are modelled as bracings. The bracings are provided at the outer peripheral columns. The response of the structure against lateral loading can be observed and the displacement is measured by using software SAP2000. The observation and results include the drift analysis obtained by the analysis of the structure considering soft storey, masonry and steel braced wall. It was observed that inter-storey drift is maximum at the ground floor. In time history analysis, inter-storey drift was found to be maximum in ground floor, then it gradually decreases in steel braced structure and lowest in masonry braced structure. In the case of pushover analysis, the drift was found to be maximum in ground floor and it gradually decreases in masonry braced structure and lowest in steel braced structure.

10. Gaurav Joshi, K.K. Pathak and Saleem Akhtar (2013)

They have done seismic analysis of soft storey building frames has 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.

11. Dr. Tushar G. Shende, Mr. Laxmikant N. Vairagade, Mr. Abhishek T. Takalkhede3 (2018)

They are concentrating on finding the best place for soft stories which is use for parking space and offices in high-rise building. Soft storey is one of the main reasons for building damage during an earthquake and has been mentioned in all investigation report. Soft storey due to increase storey height is well known subject. Infill is usually not considered as a part of load bearing system. This study investigates the soft storey behaviour due to increase in storey height, of infill's at ground floor storey by means of linear static and nonlinear static analysis for midrise reinforced concrete building displacement capacity at immediate occupancy, life safety and collapse prevision, performance level and storey drift demands. Soft storey behaviour due to change in infill's amount is evaluated in view of the displacement capacities, drift demand and structural behaviour.

12. Devendra Dohare1, Dr.Savita Maru (2014)

In this paper they have done investigation to study the seismic behaviour of soft storey building with different arrangement in soft storey building when subjected to static and dynamic earthquake loading. It is observed that, providing infill improves resistant behaviour of the structure when compared to soft storey provided.

13. Dhiraj D Ahiwale, Rushikesh R Khartode (2020)

In their work, twelve storied building are taken into account and the performance of structure evaluated by using pushover analysis in SAP 2000 software. The analytical results discussed in the nature of capacity curve, structure performance point and plastic hinge development pattern. Result indicated that, there are formations of plastic hinges at ground storey column level. To counteract the total collapse of soft storey structures, there is need to retrofit the open storey. Therefore, the alternative measures are recommended to get better the reaction of soft storey like RC shear wall, steel bracing, and infill wall.

14. Akhilesh Yadav , Dr. A. K. Mishra (2017)

Their study analyses the multiplication factor 2.5 is seen that too high for the open ground storey low rise building. the problem the problem of open ground storey low rise building cannot be properly identified through the elastic analysis as the stiffness of open ground storey building and similar bare frame is same. According to the nonlinear analysis of the OGS low rise building fails through the soft storey mechanism at a comparatively low base shear and displacement and the mode of failure is found to be brittle. In this analysis shows that the support condition of the building influences the considerable and important parameter for the multiplication factor.

15. Dande P. S., Kodag P. B. (2013)

This study talks about the provided strength and stiffness to the building frame by modified soft storey provision in two ways, (i) By providing stiff column & (ii) By providing adjacent infill wall panel at each corner of building frame. Also study has been carried out to compare modified soft storey provisions with complete infill wall frame and bare frame models.

16. Pradnya V. Sambary , Shilpa P. Kewate (2017)

Their study mainly aims at studying the effect of introducing a soft story in a building. For these three different models of G+15 RC building are being modelled and analyzed in ETABS software using response spectrum method. The stiffness contribution of the infill walls is being considered in the analysis by modelling them as equivalent diagonal struts pinned at both its end. The building is considered to be located on a medium (Type II) soil profile. The behaviour of soft storied building is compared with a fully infilled frame building in terms of seismic responses such as modal time period, story stiffness, lateral displacement and story drifts. Also, various column forces such as axial, shear, bending moment and torsional moment of the open first story of soft storied building were compared to the forces of first story columns of fully infilled frame building. Also the change in seismic responses as we move from zone III to zone V is evaluated. From the above study, it is found that introduction of soft story poses a threat to life during earthquake shaking.

17. F. Hejazi, S. Jilani, J. Noorzaei, C. Y. Chieng1, M. S. Jaafar, A. A. Abang Ali (2011)

In their study occurring of soft at the lower level of high-rise buildings subjected to earthquake has been studied. Also has been tired to investigate on adding of bracing in various arrangements to structure in order to reduce soft story effect on seismic response of building. It is lead to assess the vulnerability level of existing multi-storied buildings so that they can be retrofitted to possess the minimum requirements. This will help in minimizing the impending damages and catastrophes.

18. Akshay S. Paidalwar and G.D. Awchat (2017)

Their study investigates the soft storey behaviour due to lack of infills at ground floor storey and existence of this case by means of linear static and nonlinear static analysis for midrise reinforced concrete building. Soft storey behaviour due to change in infill's amount is evaluated in view of the displacement, drift demand and structural behaviour.

19. Yogesha D.M, Dr. Narendra B.K, Manjunatha J.K (2016)

In their study they analysed the models using ETABS-2013 software and compare each model results of mode shape and base shear using Response spectrum and Time history method, models used in this analysis are bare frame, alternative infill, alternative bracing and bracing outside in seismic zone 4. Seismic performance is mainly focused by this study. From the analysis, it is found that Base shear is more in soft storey is reduced by using bracing and infill in soft storey. This shows the poor performance of soft storey without using bracing or infill. Mode shape changes storey to storey and time to time, mode shape shows results x direction, y direction and rotational direction. All these results prove the soft storey without infill or bracing is giving poor performance compare to with infill and bracing.

20. Abdul Rauf Muqeeb, Md Faisaluddin, Shaik Abdulla (2016)

Their research work purely interacts with the effect of the soft storeys in the analysis of RC framed structures as entitled above, and in this work the soft storeys positions has been provided at different levels as shown in the analytical modelling. All the models are analyzed by using the ETABS software. The seismic analysis performed consists of the Equivalent static analysis (ESA), response spectrum analysis (RSA), and the push over analysis (PA). The seismic base shear forces, storey drifts, and the displacements has been compared with the three analysis methods as listed above. With the aid of the push over analysis the values of the ductility and the response reduction factor have been obtained. Apart from these, the performance point parameters such as spectral acceleration(Sa) , spectral displacement (Sd), Base shear(V) and the roof displacement(D) has been also illustrated in this work and a detailed information of several stages of the hinge formation (A,B,IO,LS,CP,C,D,E) has also been illustrated.

21. Pankaj Kumar Malviya,Lucky Sahu,Dr. Pankaj Singh3 (2018)

Purpose of their study is to find the soft storey location (level) in a high-rise building, so has to have minimum effect of external forces on the structural stability. This study will provide the results against various locations of soft floor with or without placing inclined columns in the building frame. Results are based on the behaviour of building against the lateral forces (Earth quake and wind Forces) as analysed by software Staad pro.

22. Pavithra R Dr. T. M. Prakash (2018)

In their work, they have studied on different location of soft stories is considered for the analysis. To study of different location on the seismic behaviour of multi-story building, linear dynamic analysis (Response spectrum analysis) in ETABs software is carried out. Different seismic parameters like time period, story shear, story displacement and story drift are checked out. The seismic behaviour of multi-story building with soft stories is carried out. For that, G+14 (Reinforced cement concrete) RCC model is selected.

23. SHALAKA DHOKANE , K. K. PATHAK (2016)

In their study, G+9 steel frames are modelled with different type of bracing pattern and different combination of soft story using software STAAD Pro. Effect of these different bracings on soft storey is studied for different parameter like column displacement, maximum deflection, storey drift, maximum bending moment, maximum axial force and maximum shear force. From the observed result best type of bracing will be selected.

24. Akshay S. Paidalwar, G.D. Awchat (2017)

They study and investigates the soft storey behaviour due to increase in storey height, of infill's at ground floor storey by means of linear static and nonlinear static analysis for midrise reinforced concrete building displacement capacity at immediate occupancy, life safety and collapse prevision, performance level and storey drift demands. Soft storey behaviour due to change in infill's amount is evaluated in view of the displacement capacities, drift demand and structural behaviour.

25. Piyush Tiwari1, P.J.Salunke2, N.G.Gore3 (2015)

Their particular objectives of the research are:

1) To Study the applicability of the Multiplication Factor of 2.5 as given by IS Code 1893 Part-1(2002), for Low Rise and Medium Rise Open ground storey Building.

2) To study the effect of infill strength and stiffness (with infill Opening) in the seismic analysis of Open ground storey building.

26. Kalappa M Sutar1 Prof Vishwanath. B. Patil2 (2014)

Their objectives of studying the problem are

(1) To know the effect of infill in the frame.

(2) To know proper modelling technique of masonry infill.

(3) To check the strength and stiffness of each storey.

(4) To know the effect of ground and successive soft storey level.

27. Amit kumar1, Mohd. Adnan2 (2019)

They aim to study the seismic behaviour and the earthquake resistance design of open ground building is analysed by the software SAP2000v20.2.0. The analysis of different models of different symmetrical structures namely G+8, G+10, G+12, and G+16 flours with equivalent diagonal strut and with the multiplication factor of 2.5 according to the IS CODE 1893- 2016 (Part I provisions. Different models of symmetrically regular shaped buildings analysed by the method of push over analysis and calculate the desire results of the considered models.

II. CONCLUSION:

1. From the review of literature its shows that use of shear wall is a good way to provide more level of ductility and getting more stable behaviour and appear to be an novel approach to reduce effect of soft story in seismic response .in the other hand, vulnerability level of existing high rise building can be increased by adding different arrangement of shear wall on building and it will help for retrofitting of structure to resist the major portion of lateral load induced by an earthquake.

2. The orientation of columns affects the lateral stiffness of the building. Hence orientations and soft storey should be introduced in a way that the lateral and vertical stiffness irregularity is not created in the building. The need for the study has increased in the recent times because of the modern trend of building open ground storey and the growing demand of using different shapes and orientation of columns for aesthetic purpose.

3. Results of this parametric study show that moments and shear forces are always maximum when first storey is soft for all types of buildings. Similarly, axial forces and drifts are also found to depend on structural and geometrical parameters.

4. Presence of soft story at the ground floor causes concentration of forces at the ground story columns causing the columns to be stressed severely, leading to the failure of the building.

5. Nonlinear static analyses of building models are carried out to compare the structure with and without infill. To check the deformation of the structure we locate the position of soft storey at ground floor level. Nonlinear static (pushover) analysis is carried out for all the building models considered. First pushover analysis is done for the gravity loads incrementally under load control. The lateral pushover analysis is followed after the gravity pushover, under displacement control for all zones.

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