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Performance Based Seismic Analysis Of Irregular Multi Storey Building With Soft-Storey: A Review

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Abstract: Presented in this paper is an updated literature review of the performance based seismic analysis of non-linear multi-storey building with Soft Storey. Performance based seismic design is an elastic design methodology and is also known as the "Performance based plastic design". The overall capacity of a structure depends on the strength and deformation capacity of the individual components of the structure. A soft storey known as weak storey is defined as a storey in a building that has less stiffness or inadequate ductility to resist the earthquake induced in building. The soft storey is storey having lot of open space.

The construction of open ground storey is very dangerous if not designed suitably and with proper care.

Keywords: Irregular Structure, Performance Based Seismic Design, Soft storey.

I. INTRODUCTION

The term "**performance**," as it relates to exposure to natural hazards, usually refers to a building's condition after a disaster, i.e., it signifies a level of damage expected or a load that can be resisted.

Building performance is an indicator of how well a structure supports the defined needs of its users. Acceptable performance indicates acceptable (or tolerable) levels of damage or condition that allow uninterrupted facility operation. Consequently, performance-based design is the process or methodology used by design professionals to create buildings that protect functionality and the continued availability of services.

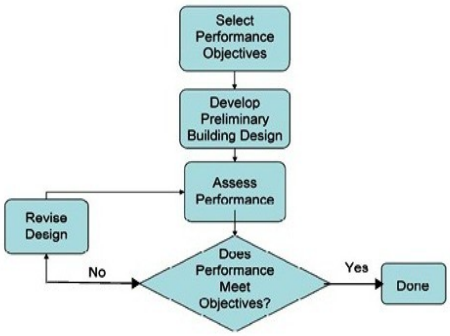

Fig.1: Performance Based Seismic Analysis Design

The performance-based design approach is not proposed as an immediate substitute for design to traditional codes. Rather, it can be viewed as an opportunity to enhance and tailor the design to match the objectives of the community's stakeholders.

Performance-based codes define acceptable or tolerable levels of risk for a variety of health, safety, and public welfare issues. The various prescriptive building, fire, and life safety codes all contain provisions for what is known as "alternative methods and materials" or "equivalency." These provisions allow for the use of methods, equipment, or materials not specified or prescribed in the code, provided the alternative is approved by the code official. A performance-based design approach can be employed under these provisions.

Performance-based design starts with selecting design criteria articulated through one or more performance objectives. Each performance objective is a statement of the acceptable risk of incurring different levels of damage and the consequential losses that occur as a result of this damage. Losses can be associated with structural or nonstructural damage, and can be expressed in the form of casualties, direct economic costs, and loss of service costs. Loss of service costs may be the most important loss component to consider.

The construction of open ground storey is very dangerous if not designed suitably and with proper care. A typical soft story building is an apartment building of three or more stories located over a ground level with large openings, such as a parking garage or series of retail businesses with large windows. This type of irregularities arises due to sudden reduction of stiffness or strength in a particular storey. For high seismic zone area, irregularity in building is perhaps a great challenge to a good structural engineer.

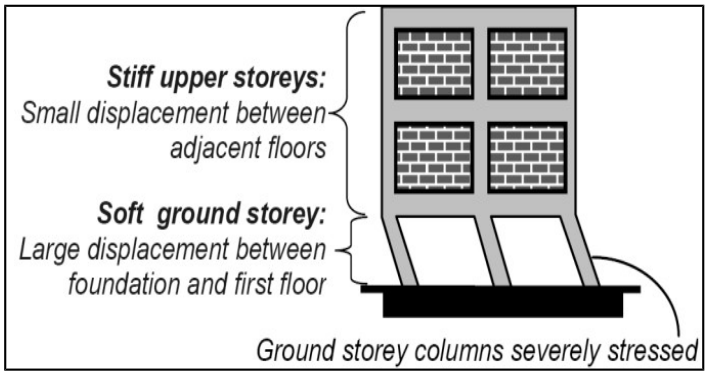

Fig.2: Soft storey column severely stressed

II. DIFFERENT RESEARCH WORK

[1] Mr. Raghavendra S. Deshpande, Dr. Mrs. Surekha A. Bhalchandra "Seismic Analysis of Reinforced Concrete Building with Soft First Storey" (2014)

Open first storey is now a day's unavoidable feature for most of the multistory buildings in urban areas for vehicle parking, shops etc. Many earthquakes in the past, have demonstrated the potential hazard associated with soft first storey buildings. The first storey become soft and weak relative to the upper stories, since the first storey is composed of only columns while the upper stories are divided by unreinforced masonry infills. Structurally those unbalances are unhealthy and the soft first storey buildings are well known for being susceptible to collapse through past big earthquakes.

In the present paper, an investigation has been performed to examine the behavior of various alternative models of same reinforced concrete moment resisting frame building with an open first storey &

unreinforced masonry infills in the upper stories. The structural action of masonry infill panels of upper stories has been taken into account by modeling them as equivalent diagonal struts. The parameters discussed include fundamental natural periods, stiffness of open first storey in relation to the upper storey, lateral displacements, inter-storey drift by linear elastic analysis using ETABS analysis package. It is noticed that significant change in stiffness between the soft storey and upper storey is responsible for increasing the strength demand on first storey columns.
The objective of this paper is to promote safety without too much changing the constructional practice of reinforced concrete structures.

[2] Prof. Rekha Shinde, Prof. Mukesh Shinde "Performance Based Seismic Analysis of a Building with Soft Storey" (2014)
"Performance-based" seismic design, which can be thought of as an explicit design for multiple limit states Analyzing structures for various levels of earthquake intensity and checking some local and/or global criteria for each level has been a popular academic exercise for the last couple of decades, but the crucial development that occurred relatively recently was the recognition of the necessity for such procedures by a number of practicing engineers influential in code drafting. The main cause of failure of multistory multi-bay reinforced concrete frames during seismic motion is the soft storey sway mechanism or column sway mechanism. The seismic inertia forces generated at its floor levels are transferred through the various beams and columns to the ground. The failure of a column can affect the stability of the whole building, but the failure of a beam causes localized effect. The main objective of this search work is to present a detailed 3 dimensional seismic analysis and capacity based design of G+3, G+8 & G+15 storied three bay reinforced concrete frame. The report provides an introduction to the earthquake, effects, designing of the buildings and studies review of literature pertaining to performance based seismic analysis. It highlights various aspects related to the capacity based designing and explains about Limit State design which an old method of building designing. The study reveals modeling and analysis. The capacity based design of G+3; G+8 & G+15 of old and new building design methods have been modeled and analyzed. The report draws out the result of study and provides a comparative study. The project report also provides a comprehensive conclusion and offers a scope for future research as well.

[3] Devendra Dohare, Dr.Savita Maru "Seismic Behavior of soft Storey Building: A Critical Review" (2014)
Soft first storey is a typical feature in the modern multi-storey constructions in urban India. Though multi-storeyed buildings with soft storey floor are inherently vulnerable to collapse due to earthquake, their construction is still widespread in the developing like India. Functional and Social need to provide car parking space at ground level and for offices open stories at different level of structure far out-weighs the warning against such buildings from engineering community. With the availability of fast computers, so that software usage in civil engineering has greatly reduced the complexities of different aspects in the analysis and design of projects. In this paper an investigation has been made 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.

[4] Ranjit V. Surve, Prof. D. S. Jagtap, Prof. Y. P. Pawar "Performance based Analysis of Multistoried Building with Soft Storey at Different Levels" (2015)
Many urban multistorey building in India today have open first storey as an inescapable feature. This open first storey being adopted to accommodate parking or reception lobbies in the storey. Though multistoried building with ground soft storey are fenceless to collapse due to earthquake load. Now a days there is functional and social need to provide soft storey at different level. In present thesis we are concentrating on finding the best place for soft storey in high rise building with GL. also we are focusing

on natural time period of multistoried structure. This paper aims to evaluate the zone-V selected reinforce concrete building to conduct the nonlinear static pushover analysis. The structural engineer using the nonlinear static pushover method for Modeling and analysis of structure. We determine the nonlinear properties of each component in the structure. The push-over analysis shows the pushover curves, capacity spectrum curve, plastic hinges, performance level of building.

[5] Vipin V. Halde, Aditi H. Deshmukh "REVIEW ON BEHAVIOR OF SOFT STOREY IN BUILDING" (2015)

In high rise building or multi storey building, soft storey construction is a typical feature because of urbanization and the space occupancy considerations. These provisions reduce the stiffness of the lateral load resisting system and a progressive collapse becomes unavoidable in a severe earthquake for such buildings due to soft storey. This storey level containing the concrete columns which were unable to provide adequate shear resistance, hence damage and collapse are most often observed in soft story buildings during the earthquake. In the current study the focus is on the investigation of the effect of a soft storey on the behaviour of a structure and effect of masonry infill on structure.

[6] Silpa Rani M V, Aiswarya S "Seismic Response of Irregular RC Building with Soft Storey at Different Levels" (2016)

Vertical irregularities in buildings are very common feature in urban area, large number of vertical irregular buildings exist in modern urban infrastructures. Soft storey building is a multi-story building in which one storey is kept open for the purpose of vehicle parking, shops, commercial purposes etc. This paper deals with the study of seismic response of a building with soft storeys at different level. The study consists the modelling of a G+6 storied irregular RC building. The modeling of the whole building is carried out using the computer program STAAD.Pro V8i software. Parametric studies on displacement, inter storey drift and base shear have been carried out using equivalent static analysis to investigate the influence of these parameter on the seismic behavior of buildings with soft storey. The selected building is analyzed through five models and the comparison of result is carried out.

[7] K.Vamsi Satyanarayana, Vinodh kumar "Seismic Response of Rc Frame Building With Soft Storey At Different Floor Levels" (2016)

Many multistorey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storeys. The upper storeys have brick infilled wall panels. Reinforced concrete (RC) frame buildings with masonry infill walls have been widely constructed for commercial and may effect .so by using to avoid lateral displacement and storey drift, stiffness of masonary infill, performance of soft storey building by using ETABS provided columns and adjacent infills at each corner of building at different floor levels at different zones.

[8] B. Lalitha Chandrahas, P. Polu Raju, "Behaviour of Soft Storey RC Framed Building under Seismic Loading" (2017)

Indian urbanization has led to increase in demand for construction of commercial floors, parking facilities in the lower stories of building. The location of open storey at different levels in a building is most vulnerable to seismic forces which may lead to either partial damage or collapse of the building above that floor. The conventional design methods are not accountable for such failures in past earthquakes. In this article attempts are made to explain the factors that impact the soft storey failure in a building. Pushover analysis has been carried out for a G+9 multistoried building to study the soft storey effect at different floor levels using SAP 2000 software. The behavior of RC framed building with soft storey under seismic loading has been observed in terms of hinge formation patterns, total lateral drift, storey

shear, overturning moment, and time period for considered structure. It is observed that infill wall has significant effect in the stiffness and lateral resistance of frame.

[9] Akshay S. Paidalwar, G.D. Awchat, "Performance Based Analysis of Open Ground Storey" (2017)

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. Change in amount infill walls between stories also results in soft story. These are usually not considered as a part of load bearing system. This study investigates the soft storey behavior 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 behavior due to change in infill's amount is evaluated in view of the displacement capacities, drift demand and structural behavior.

III. CONCLUSION

From present study it can be concluded that, the regular structure is found better than the irregular structure. The geometrically irregular shaped buildings experienced higher displacement than regular shaped building. To get better performance required of the RCC building then, new seismic design provisions require Structure engineer perform both static and dynamic analysis for the design of the structure.

But nowadays the need and demand of the modern era and growing population has made the architects or engineers forced towards planning of irregular structures which needs additional careful structural analysis so that acceptable behaviour of the structures can be ensured throughout a devastating earthquake. So, seismic analysis must be done for regular and irregular medium to high-rise buildings.

IV. REFERENCES

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[3] Devendra Dohare, Dr.Savita Maru "Seismic Behavior of soft Storey Building: A Critical Review" *International Journal of Engineering Research and General Science*, Volume 2, Issue 6, October-November, 2014

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[7] K.Vamsi Satyanarayana, Vinodh kumar, "*International Journal of Engineering Trends and Technology (IJETT)* – Volume-42 Number-4 - December 2016"

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