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A REVIEW ON ANALYSIS OF OPEN GROUND STORIED STRUCTURE RETROFITTED BY CROSS-STEEL BRACINGS

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Abstract

Shear wall systems are one of the most commonly used lateral load resisting in high rise buildings. This case study focuses on mitigating the open ground storey (OGS) effect in a seven-storied residential building situated in Guwahati (India) by considering cross-steel bracings as a possible retrofitting scheme. Nonlinear dynamic procedure (NDP) will be adopted and scaled intensities of the acceleration time history of a suite of six earthquakes will be used. Appropriate scale factors were calculated by studying the peak ground acceleration (PGA) of these earthquakes to scale them as per the target response spectrum of Zone-V in accordance with IS:1893(Part-1)-2002. The effect of infill walls in the considered OGS building will be studied. The framed structure will be subjected to lateral and gravity loading per IS provision and the response of the buildings will be analyzed in terms of modal time periods, capacity spectrum, sequence of hinge formation, storey displacement, storey drift, and lateral shear. A comparative analysis will then be carried out. Finally, conclusions will be drawn regarding the suitability of cross-steel braces as an effective retrofitting technique for the considered medium-rise building.

Keywords: *Infill walls; Nonlinear dynamic procedure; Performance points; Scaling of ground motion; Soft storey.*

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1. Introduction

The increase in urbanization for the past few years has made vehicle parking a major concern. In order to overcome this usually, we provide the first storey of the building for parking. The open ground storied structure is a structure in which an infill wall is absent at the ground storey for the purpose of parking or social gathering. According to earthquake reports, the structure having an open ground storey leads to complete collapse due the absence of infill wall. Distribution of strength, mass, stiffness should be consistent throughout the building both vertically and horizontally as the design philosophy of structures. Improper orientation of walls results in soft storey, weak storey and torsion effect. The severe damage can be seen on the structure due to irregularity of structures. Due to modern era of construction the buildings without open ground storey is unavoidable because there is a shortage

of area for parking so we have to provide some special measures on the structure to mitigate the effect of soft storey on the structure. It is very necessary to conduct an in-depth study on the nonlinear behaviour of the structure so that it gives the proper response of the structure during earthquakes. In recent earthquakes building structures having soft stories, collapsed and suffered major structural damage. Large open areas with exterior walls and less infill in the ground floor compared to upper floors are the cause of damages. In such buildings, the stiffness of the lateral load resisting systems at those stories is quite less than the stories above or below. The nearness of infill walls in the upper accounts of the open ground storied structure expands the stiffness of the structure, as found in an ordinary infilled surrounded structure.

Characteristics of an earthquake-resistant structure

- Good Structural Configuration - The size shape and system of load transfer should be such that a direct and smooth flow of inertia forces to the ground is ensured.
- Lateral Strength - The lateral forces resisting capacity of the structure should be atleast enough so as to prevent a complete collapse.
- Adequate Stiffness - The stiffness should be such that the earthquake-induced deformations in the structure should not damage the structural members under minor or moderate shaking.
- Ductility - It requires proper detailing strategies and design methodologies.
- Measures suggested by IS codes for reducing EQ effects on buildings-

Here are some of the common techniques adopted to strengthen the building against Seismic forces and deformations:

- Provision of Horizontal bands
- Provision of Vertical reinforcements
- Avoiding Open-Ground Storey Configuration
- Avoiding mass or structural irregularities in the structure
- Provision of Shear walls

2. Literature Review

1. Rajandre Desai, Rupal Desai. Latur Earthquake Rehabilitation (Case Study). The authors have submitted this case study paper at," Workshop of low-cost housing and community participation in construction," at Cebu Philippines, in reference to 1992 Latur earthquake. They have pointed out the fact of majority of houses collapsed, were from low-cost category. About reasons of the collapse they strongly opine that, these traditionally constructed were, the construction of these houses, is evolution based on wisdom and experience of centuries of respective areas, not only in Kachchh but all over the country The day in and day out, use of cement and steel is skyrocketing, leading to very high rate of exploration.

2. Nicolas Hurtado Tecnica. The benefits as explained are safety to occupants in and around the structure, property, secondary benefits of the saving in cost, such as medical expenditure, temporary relocation cost- loss of building use, litigation cost and the time that would have required to face these situations. And finally, has cautioned, that there is nothing like full proof earthquake resistant structure, but the retrofitting will enhance the performance of the structures.

3. M. Haseeb, Xinhailu, Aneesa Bibi, Jahan ZabKhan. The majority of the houses collapses were located on the hill slopes or in vicinity hence, when earthquake struck; landslides, rock slides and subsidence followed it, they automatically became culprit of not single but quadraphonic attack.

4. Ralucu Plesu, George Taranu, Denial Covetarin, Ionut-Dan Gardinariu (2011) In this paper authors are reviewing both the traditional construction and their traditional methods of retrofitting of masonry buildings. They are weathering, aging, unaccounted settlement of the foundation. They further, opinion that these factors and then consideration; of capacities as tensile, shear, flexure, member's stability, strength or stiffness or both should be accounted in deciding the methodology for retrofit, on case . This approach will give justification to strengthening of structure.

5. Joseph, Sashi K Kunnath JSE Jan.(1997) paper no. 10373. In high rise buildings, reliance only on the inertia force developed by roof or top stories, as design criteria will be underestimation. Therefore, authors studied. "Acceleration displacement response spectrum (ADRS) format, in this paper. A retrofitted model was tested with same parameters and results were tabulated. The comparison of various proposed seismic retrofitting schemes can be done, as in this case study, for relative improvement in strength and deformation demands and capacities of original and modified structure. There is one can ascertain the best suitable method for adoption.

6. Murty C.R.V., Datta Jayanta, Agrawal S.K.(EE&EV). V.3; no.2 Dec. 2004. Twin Lintel Belt in Steel for Seismic Strengthening of Brick Masonry Buildings. The authors tested the brick masonry structures with precast R.C. Roofing for the aim of strengthening it. The collapse can be attributed to out-of-plane, in-plane. And improper connection between slab / roof with masonry walls. Their findings are twin lintel belt along with vertical corner reinforcement, and proper anchorage between slab /roof though provide better seismic resistance as compared to traditional repair methods. They opine that, this system is vulnerable to strong horizontal and vertical ground motions.

7. Sekar T.; Ramaswamy S.N.; Nampoothari N.V.N. Study on Strengthening of Brick Masonry Structures in Fire Work Industry against Accidental Explosion. (AJCE, V.13, no.6.2012 p.743. Authors have published this paper with the aim to suggest retrofitting measures for safe guarding work force and explosives contents stored in single storied structures in explosive producing factories. The explosion creates seismic type simulations and the major dominating action in single storied structures is due to horizontal force. After carrying out the experiments on models authors concluded and recommend to provide seismic protective bands at plinth, lintel, and roof level, RCC Columns at jambs of door.

3. Need For Study

In the present case study, a seven storied residential building was taken up. The buildings is situated at Guwahati, India which lies in the most seismically active zone of the country. Each floor, apart from the ground floor had four independent 3BHK flats with a box type shear wall at one end, serving the purpose of lift shaft and dog-legged stairs on the other end. This study discussed the behavior of existing structure and retrofitted structure in nonlinear analysis using ETABS software so that we can conclude the provision of shear wall or cross bracing on that locality is suitable or not.

4. Scope of the work

- Shear walls and cross bracing are considered for the structure at different levels for the study in Time History Analysis and Pushover Analysis.
- Other mitigating measures can be used.
- The plan irregularities can be considered and analyzed using this method.

5. Conclusion

- Before mentioned discussions of nonlinear dynamic analysis all revealed cross bracing retrofitted models to exhibit enhanced performance characteristics.
- A financial feasibility study was also carried out, taking in to consideration the cost-benefit ratio, and it can be concluded that using cross steel braces is an effective technique of retrofitting the structure against lateral loadings.

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