"Seismic Analysis of A Mid-Rise Existing Building For Retrofication Using Analysis Tool Staad.Pro: A Review"

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Abstract- *The design recommendations contained herein are applicable to the seismic design of structures that generally have the unique seismic response characteristics of tall buildings including:*

- *A fundamental translational period of vibration significantly in excess of 1 second.*
- *Significant mass participation and lateral response in higher modes of vibration.*
- *A seismic-force-resisting system with a slender aspect ratio such that significant portions of the lateral drift result from axial deformation of the walls and/or columns as compared to shearing deformation of the frames or walls. The Pacific Earthquake Engineering Research Center developed these Guidelines as an alternative means of compliance with the strength requirements for structural resistance to seismic loads specified in I.S. 1893 part-1 for Risk Category II structures considering the seismic hazard typical in the Western United States. Such structures are intended to resist strong earthquake motion through inelastic response of their structural components. These recommendations may be applicable to the seismic design of structures that do not exhibit substantial inelastic response or that are located in regions with seismicity somewhat different than the Western United States. However, some modification may be appropriate.*

In this paper we are presenting review of previous papers related to retrofitting technique in building structure.

Keywords- Analysis Tool, Structure analysis, Retrofitting, Review, building frame, seismic analysis.

I. INTRODUCTION

Disasters per se have been dealt by management experts, government and semi-government agencies in the past and the role of engineers has been mostly relegated to retrofitting and strengthening post disaster. Most international codes have now started addressing the situation as disasters are occurring at a higher frequency across the globe. Traditionally declared disaster prone zones are ever expanding into new domains. Thus awareness among engineers, architects and equally among non-engineers has increased and resulted into various alternatives for mitigation and prevention aspects. Available literature examines individual aspects of each disaster. International guidelines describe the methodology that can be adopted for structural analysis and design for earthquakes, but there is no standardized protocol for other disasters. Thus it is difficult to truly handle the complex dynamics of real-time forces of earthquake, wind, fire or flood. Proprietary software on the other hand leave very little scope of flexibility to incorporate specific aspects of forces that could have disastrous effects. Once again the catch in available software is the modeling effort and the assurance of a robust model depicting the real life situation. Thus both literature and software do not enable the engineer to have, on hand, a mechanism of finding a solution to his customized needs nor to study the effects in a post processor instead of tabulated or two-dimensional graphical outputs. Besides, there has been no attempt at mirroring the outputs in a virtual environment which would show the actual behavior of the building in a real-life manner. Studies have thus been highly focused on addressing the structural aspects of various disasters. The review of such available literature for the current research is presented here in nine major parts:

- Pushover technique for performance based analysis of buildings.
- Damage and retrofit options for seismic forces
- Virtual reality in structural engineering
- Structural aspects of mitigation of cyclonic wind.

- Structural alternatives for mitigation of flood effects
- Fire loads on structures
- Damage and repair for Blasts and Tsunami

Structural alternatives for mitigation of flood effects:

1. RajatShrivastava, Sitesh Kumar Singh (may 2018)	Seismic Analysis and Design of G+9 RCC Residential Building in STADD.Pro for zone II region	• Seismic investigation of structure for static and dynamic examination for in standard minute seismic investigation opposing casing. • The author here as considered a private G+9 residential apartment for investigation situated in zone II district Delhi in India. • The structure designing and analysis was performed using the analysis tool STADD.Pro for various loading conditions. • The base necessities relating to the basic security of structures are being secured by the method for setting out the base plan loads which must be accepted for dead loads, forced burdens, and other outside loadings. Total structure was analyzed by computer with using STAAD.PRO software.
2. Dr. G.S.Suresh, Mr. Sachin (2015)	Seismic Performance Evaluation and Retrofitting of RC Members and Joints	• Here the author considered structure designed and constructed for only gravity loads for the purpose of evaluation and retrofitting work. Retrofitting to increase the capacity of elements is suggested for the elements having ratio of Demand to capacity more than 1. • Finite element software ETABS is used to determine the seismic demand of each element. • Here the author retrofitted the deficient columns and re-analyzed to check performance of the structure in non-linear analysis and the Performance of this retrofitted structure was then compared with the existing reinforcement structure and it is found that structure after retrofit have more base shear capacity and displacement capacity, storey drift of the retrofitted structure has decreased thereby ensuring a maximum safety of the structure even to the zone3 level of seismic intensity. • From the present study it is brought out that structural elements designed only for gravity loads have less vulnerability to collapse in zone 2 level of seismic intensity, and for zone 3 level of seismic intensity itself structural elements fails to perform both serviceability limit state as well as ultimate strength limit state.
3. J.Omprakash1, S.Tousif Ehtesham.et.at (2018)	Analysis and Design of Commercial Building Using ETABS	• Here the author performed analysis and design of commercial building using Etabs considering a G+9 Storey building where analysis was carried out by static method and design was done as per IS 456:2000 guidelines. • The various parameters included in the investigation was the analysis of building for seismic loading with two different zones III and zone V with three different forms of soil. • The structural performance is analyzed in two different models I.e. without bracings and with bracings of X shape,

		the displacement of 50% is reduced when lateral system are provided. Zone wise comparison in made for each soil and it is observed that average of 50% is reduced in displacement, shear, and moment.
4. SukomalMandal, B S Sudharshan, et.at (2017)	Upgradation of Existing Multi-Storey RC Building by Retrofitting	• Here the author describes describes a retrofitting system of the existing four-storey reinforced concrete building located in PES University Bangalore, designed for vertical loads of extra two-storey structure. The structural analysis performed on the inspected building has shown its inability to withstand any additional loads. • the redesign of structures with inability to withstand any further loads is performed through retrofitting of existing columns and footings has been assessed through structural analysis carried out using STAAD-Pro software. • The author concluded that Present footings and columns are just capable of taking all loads for the existing G+3 building besides Present footings and columns are not capable of taking the loads of G+5 building with existing sizes of footings and columns. • The retrofitting design carried out for G+5 building shows that the retrofitted G+5 building is safe from all loads except seismic load which is not considered for the present study.
5. MassimilianoFerra ioli, Alberto Mandara, et.at (2009)	Performance Based Seismic retrofitting of irregular RC building structures	• Here the author considered a combination of performance criteria regarding both structural members and non-structural components at the different limit states and identified two methods of seismic retrofitting based on concentric and eccentric steel bracing are applied, and their weak points. • As an alternative to incremental response history analysis, an incremental nonlinear static procedure based on the capacity spectrum method and the inelastic demand response spectra is used for the seismic assessment. The lateral force distribution, the higher modes contribution and the torsional effects are investigated. • The performance evaluation of Koletti Building in Athens was carried out. The results show that the combination of higher modes contribution does not affect nonlinear static response of the building. In other words, the importance of the "MDOF Effects" seems to be not so high. Furthermore, the torsional effects seem to be little important also for the existing building. The retrofit bracing systems increase both the lateral and the torsional stiffness of the building. Consequently, both the period of the bending mode shapes and the participation mass ratios of the torsional mode shape decrease. In other words, the bracing system mitigate the multidirectional seismic effects. The period shortening increases the seismic demand of the buildings that fail in the constant-velocity region of the response spectrum and so the structure attracts higher seismic demands. • On the contrary, the retrofit with EBF gives moderate

		stiffening and sensible increasing of energy dissipation capacity if compared to CBF building and existing building. The seismic vulnerability is decreased both increasing the capacity of the structure by steel bracing, and lowering the seismic demand by energy dissipation in the shear links.
6. Rishabh Sharma, Dr. Shailendra Kumar Tiwary, et.at (2018)	Seismic Analysis and Retrofitting of a Multi-Storey RC Building	• Here at the author analyzed a G+10 storey building for seismic zone III as per IS 1893(Part 1):2002 using ETABS 2016 software and investigated The seismic performance of reinforced concrete buildings rehabilitated using concentric steel bracing. • The bracings were provided for peripheral columns and building was analyzed for models with X type bracing, Diagonal bracing, V type bracing, Inverted V type bracing, Combined V type bracing and K type bracing and compared with an Unbraced frame. • The analysis of the G+10 storey building with different types of structures, here the author concluded that displacement of structure decreases with application of bracing system. Lateral displacement and storey drifts are minimum for inverted 'V' braced frame as compared to 'V' braced frame. The concept of using steel bracing is one of the advantageous concept which can be used to strengthen or retrofit the existing structures.
7. Ramanand Shukla, PrithwishSaha (2018)	Comparative study of a G+10 storied building using Etabs and Stadd	• Here the author carried out analysis of a G+10 storied building with a simple plan dimension in both Stadd.Pro and ETABS which was mainly limited to basic comparison between their analytical results under vertical loadings. • The author here further extended their research while applying horizontal loads and plan position of shear walls developing horizontal base shear at different support positions. • Here the author concluded while comparing the various models considered in the research, it was found that model with a centrally placed shear wall is most efficient in terms of handling the base shear.
8. MunshiMdRasel, Md Asif Rahman (2015)	Retrofitting Process of an Existing Building With Respect To Seismic Consideration in Bangladesh	• The objective behind the author research work was to evaluate the seismic performance on an existing structure where the author used the Equivalent Static Force Method according to BNBC 1993 in order to apply earthquake loads. • The Demand Capacity Ratio (DCR) is carried out for beams and columns in order to evaluate the member for seismic loads. Then retrofitting is carried out for the failed beams and columns. Steel Plating Retrofitting Method is applied for the beams and Concrete Jacketing Retrofitting Method is applied for the columns. It was recommended from this study that the buildings which were not built with seismic consideration can be evaluated and retrofitted following the research presented in this study. • Here author research results proved that Maximum DCR

		for beams is found to be 1.373 at Level 02 which is 37.3% greater than the capacity. Similarly maximum DCR for column is found 1.09923 at Level 01 which is 9.923% greater than the capacity. In case of retrofitting of beam by Steel Plating it is found that the capacity achieved by retrofitting method is 180.74 k-ft which is more than the target capacity of 147.45 k-ft. The capacity increase is 22.58%. In case of retrofitting of interior column by Concrete Jacketing, the capacity achieved by retrofitting method is 1935.80 kip which is more than the demand 1260.51 kip. The capacity increase is 53.57%.

II. CONCLUSION

The following conclusions are observed as:

1. Staad.pro is advance analysis tool for structuralanalysis.
2. Researchers determined that retrofitting in a structure minimizes the bending moment and forces generated due to loads and its age which results in increase in structure life with stability and safety.
3. It is observed that for seismic force resistivity in an old structure, effect of retrofitting members are resisting forces and increases stability.
4. It is observed that none of the researchers opted software implementation to assign strength available and to provide strength using pre analysis in analysis tool.

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