Performance based Analysis of Shear Wall for Tall Building: A Review

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Abstract—Presented in this Paper is an updated literature review of Performance-Based Seismic Analysis (PBSA) of tall building structure With Shear Wall. Performance Based Seismic Analysis (PBSA) is the elastic methodology or is an approach to the analysis of any complexity of building under different ground motions. Performance-Based Seismic Analysis (PBSA) is the modern approach to earthquake resistant design. A shear wall is a structural system composed of braced panels to counter the effects of lateral load acting on a structure. Performance-Based Analysis is widely recognized as an ideal method for use in the future practice of seismic analysis. The Review of the paper shows that a huge scope of research work is needed for development of Performance-Based Seismic Analysis (PBSA) for different type of structures. The finding shows the difference between the old and the new method of the PBSA. And what are the parameters which are changing as we introduce new PBSA methods.

Key words: Performance Based Analysis, Capacity Based Analysis, Seismic Evaluation, Limit State Design

I. INTRODUCTION

Civil Engineering Structures are mainly design to resist dead load and live load (Static Load) and the dynamic loads are generally not considered. This feature of ignoring the dynamic loads results in the cause of disaster, mainly in case of earthquake. Recent example of this category is Nepal Earthquake occurred on 25, April 2015. This has created a growing interest and need for Performance-Based Seismic Analysis.

The Performance Based Earthquake Engineering (PBEE) also known as the Performance Based Seismic Engineering (PBSE) is a rapidly growing idea that is present in all guidelines that were recently published: Vision 2000 (SEAOC, 1995), ATC40 (ATC, 1996), FEMA273 (FEMA, 1997), and SAC/FEMA350 (FEMA, 2000a). PBEE implies design, evaluation, construction, monitoring the function and maintenance of engineered facilities whose performance under seismic loads responds to the diverse needs and objectives of owners, users and society. In other words, the building is designed to meet specific requirements according to the users of building but taking care of the standards of Structural engineering.

The basic concept of Capacity Based Design and Analysis of structure is the spreading of inelastic deformation demands throughout the structures in such a way that the formation of plastic hinges takes place at predetermined positions and sequences. In other words, the capacity design is based on deterministic allocation of strength and ductility in the structure element for successful response and collapse prevention during a catastrophic earthquake by rationally choosing successive regions of energy dissipation so that predecided energy dissipation mechanism would hold throughout the seismic action. The reason to name the capacity design is that in the yielding condition, the strength developed in weaker member is related to the capacity of the stronger member.

II. ADVANTAGE OF PBSA METHODS

The advantages of PBSA over the methodologies used in the current seismic design code and analysis are summarized as below:

- More reliable attainment of intended seismic performance.
- Reduced construction cost.
- Accommodation of Architectural features that may otherwise be attainable.
- Use of innovative structural systems and materials.
- The building will meet the prescribed performance objectives reliably with accepted confidence.
- An analytical method through which the structural behavior, particularly the nonlinear behavior is rationally obtained.
- Multilevel seismic hazards are considered with an emphasis on the transparency of performance objectives.

III. DIFFERENT RESEARCH WORK

Savan Javiya, Asst. prof. Bibhu Bibhuti, (2017) [1] had studied about the performance based analysis of RCC Building using pushover analysis. In the present study the nonlinear response of RCC frame using finite element program (SAP2000) under the loading had been carried out with the intention to investigate the relative importance of several factors of a nonlinear analysis of RCC frames. The author had concluded that the results obtained for G+10 for this case leads to the failure of the building. The retrofitting of the building is also became necessary after push over analysis methods.

Md. Samdani Azad, Syed Hazni Abd Gani, (2016) [2] have performed a comparative study of seismic analysis of multistory buildings with shear wall and bracing systems. The Paper contains a numerical approach to show discontinuity between the shear wall system and steel bracing system. As a result, the reinforced concrete buildings considering shear wall and steel bracing systems at positions and orientations are simplified. The Present study concluded that the reinforced building with shear wall is more stable that the Steel bracing system. Positioning of shear wall is dominating point. Along with this, the orientation of floor bracing is of less significant scrutinizing with the vertical oriented bracing system.

Rajan L. Wankhade, Amarsinh B. Landage, (2016) [3] had studied the Performance Based Analysis and Design of Building Frames with Earthquake Loading for G+9 Building. The performance of the structure considering potential hazards and uncertainties in assessment of the actual building responses are studied. Performance objectives are
selected in performance based analysis and design followed by the development of a preliminary design. Further redesign and reassessment are carried out until the desired performance levels are achieved. Buildings frames are analyzed and redesigned by improving the reinforcement of various components of building frames. Multi storied building frames are analyzed enhancing the reinforcement of structural members in different combination as well as at different storey levels. The results of the analysis and design performed to meet required performance are presented in terms of displacement and forces. With increase in the percentage of reinforcement in the beams and columns at different levels various cases are considered in the performance based design. As reinforcement is increased reduction in roof displacement is observed for interior column and for corner and mid-face columns which is appreciable. On the other hand performance of the building decreases as the sectional sizes of beams and columns are reduced while keeping same reinforcement. However, with the increase in reinforcement of storey columns, there is quite an appreciable change in the base force carrying capacity of the structure. The combination of change of reinforcement in beams and columns both show a consistent increase in base force capacity. The performance based seismic analysis and design obtained by above procedure satisfies the acceptance criteria for immediate occupancy and life safety limit states for various intensities of earthquakes.

Dimpleben P. Sonwane, Prof. Dr. Kiran B. Ladhanare, Prof. Rekha Shinde, Prof. Mukesh Shinde, (2014) [7] had performed a comparative study on Performance Based Seismic Analysis of a Building with Soft Storey. 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 capacity based design of G+3; G+8 & G+15 of old and new building design methods have been modeled and analyzed. On the basis of results the author had concluded that Capacity based earthquake resistant design is futuristic approach to design of reinforced concrete structures especially for multi-bay multi storied reinforced concrete buildings. This concept is to restrict the formation of plastic hinges in the beams only hence collapse occurs through the beam mechanism only, which localize the failure and hence leads to less destruction and loss of lives. This method also eliminates the possibility of shear mode of failure by making shear capacity of elements more than their moment capacity. Thus, it is observed that more research work is needed especially for development of PBED method for various other different types of structures. It is important to note that in the PBED method, control of drift and yielding is built into the design process from the very start, eliminating or minimizing the need for lengthy iterations to arrive at the final design.

Dr. S. N. Tande, Reshama M. Karad, (2013) [7] had performed a comparative study on Performance Based Inelastic Seismic Analysis of Buildings. The present paper deals with detailed discussions on non-linear static analysis methods various structural performance levels of building. Seismic evaluation followed by information about various strengthening techniques for beam and column. The study includes the Pushover Analysis of G+6 storey building using SAP 2000 with default and user-defined hinges. The author had concluded that the point at which the capacity curve intersects the reduced demand curve represents the performance point at which capacity and demand are equal. As displacement increase, the period of the structure lengths and reduces demand. Hence, optimum point should have a higher capacity for a lesser displacement. Hence, structure is very safe to use.

Mrugesh D. Shah, Atul N. Desai, Sumant B Patel, (2011) [8] had performed a comparative study on Performance Based Analysis of R.C.C. Frames using ETABS 9.7. In the present paper, two typical new R.C.C. buildings were taken for analysis: G+4 and G+10 to cover the broader spectrum of low rise & high rise building construction.
Different modeling issues were incorporated through nine model for G+4 building and G+10 building were; bare frame (without infill), having infill as membrane, replacing infill as a equivalent strut in previous model. All three conditions for 2×2, 3×3, 4×4 bays. From the results, the author concluded for G+4 and G+10 storeys in bare frame without infill having lesser lateral load capacity (Performance point value) compare to bare frame with infill as membrane and bare frame with infill having lesser lateral load capacity compare to bar frame with equivalent strut. Also conclude that as the no of bays increases lateral load carrying capacity increases but with the increase in bays corresponding displacement is not increases. Also conclude that as the no of storeys increases lateral load carrying capacity does not increase but corresponding displacement increases.

J P Moehle (2008) [9] had performed a comparative study on Performance-Based Seismic Design Of Tall Buildings In The U.S. Performance-based earthquake engineering increasingly is being used as an approach to the design of tall buildings in the U.S. Available software, research results, and experience gained through real building applications are providing a basis for effective application of nonlinear analysis procedures. Proportions and details superior to those obtained using the prescriptive requirements of the building code can be determined by such analysis, leading to greater confidence in building performance characteristics including serviceability and safety.

M J N Priestley (2000) [10] had outlined and compared the three method of Performance Based Seismic Design. And discussed them in the context of traditional forced based seismic design and earlier design approaches which contained some elements of performance based design. The Present Paper had emphasized on the soil-related problems, and the incorporation of soil-structure interaction into performance based design. In the Present paper, the author had explained about the Performance limit states, Design displacement spectra, and Equivalent single degree of freedom model. It was emphasized that the key merits of the design methods are simplicity and rationality. It was shown that the significant differences in seismic performance can be expected from structure design to the approach when compared with the conventional force based/ displacement check approaches. It was also shown that this is very simple to apply results in uniform level of seismic risk.

Katsuhiro Yamawaki, Haruyuki Kitamura, Yasuhiro Tsuneki, Nobuyuki Mori and Satoru Fukai, (2000) [11] had developed a performance based design methodology in which various aspects of seismic performances in buildings were clearly defined. Also, a “seismic performance menu” had also been prepared to provide common bases for clients and designers in determining design seismic performances of each specific building. The authors had also established technical design targets corresponding to each performance level and the design values i.e., required structural strength levels to satisfy the technical design targets. The authors had proposed a performance-based seismic design methodology to respond a variety of demands of the clients, where various levels of performance design target were clearly defined and described. In addition, a building seismic performance menu was also provided for standard types of building use. The authors had believed a more reliable design methodology to realize integrated performance requirements in buildings can be established taking the concept of life cycle cost and of the risk management into account.

IV. CONCLUSION

This Paper reports on the Performance-Based Analysis of Shear Wall For Tall Building. Several approaches for the PBSA method proposed by researchers have been briefly reviewed in this paper and it is observed that more research work is needed especially for development of PBSA method for various other different types of structures. It is important to note that in the Performance Based Seismic analysis and design methods, control of drift and yielding is built into the design and analysis process from the very start, minimizing the need for lengthy iterations to arrive at the final design. Other advantages include the fact that innovative structural schemes can be developed by selecting suitable yielding members and devices and placing them at strategic locations, while the designated non-yielding members can be detailed for minimum ductility capacity. Some researcher had concluded that by providing shear wall to high rise building, seismic behavior will be affected to greater extend and also the strength and stiffness of building will be increased.

REFERENCES


