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A REVIEW ON PERFORMANCE BASED DESIGN OF MULTI STORY BUILDING

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Abstract—*Earthquakes are known to produce one of the most destructive forces on earth. It has been seen that during past earthquakes many of the buildings were collapsed. Therefore, realistic method for analysis and design are required. Performance Based Design is the modern approach for earthquake resistant design. It is an attempt to predict the performance of buildings under expected seismic event. A structure designed with Performance Based Design (PBD) concept does not developed undesirable failure mechanism during earthquake. The analysis can be performed on new as well as existing buildings and the performance of buildings in future earthquake can be evaluated. Main objective of these study is to understand the Performance Based Design, Pushover Analysis, Different methods for Pushover Analysis, Capacity Curve, Demand Curve, Performance Curve, Base Shear and Displacement.*

Keywords- *Performance Base Design, Pushover Analysis, Performance Point, Capacity Curve, Demand Curve*

I. INTRODUCTIO N

Amongst the natural hazards, earthquakes have the potential for causing the greatest damages. Since earthquake forces are random in nature & unpredictable, the engineering tools needs to be sharpened for analysing structures under the action of these forces. Performance based design is gaining a new dimension in the seismic design philosophy wherein the near field ground motion (usually acceleration) is to be considered. Earthquake loads are to be carefully modelled so as to assess the real behaviour of structure with a clear understanding that damage is expected but it should be regulated. In this context pushover analysis which is an iterative procedure shall be looked upon as an alternative for the orthodox analysis procedures. This study focuses on pushover analysis of multi-storey RC framed buildings subjecting them to monotonically increasing lateral forces with an invariant height wise distribution until the present performance level (target displacement) is reached. The promise of performance-based seismic engineering (PBSE) is to produce structures with predictable seismic performance. To turn this promise into a reality, a comprehensive and well-coordinated effort by professionals from several disciplines is required.[1]

Basic concept of Performance Based Seismic Design is to provide engineers with the capability to design buildings that have a predictable and reliable performance in earthquakes. Performance based Seismic design is an elastic design methodology done on the probable performance of the building under input ground motions.

The performance-based seismic design process explicitly evaluates how a building is likely to perform; given the potential hazard it is likely to experience, considering uncertainties inherent in the quantification of potential hazard and uncertainties in assessment of the actual building response.[2]

In performance-based design, identifying and assessing the performance capability of a building is an integral part of the design process, and guides the many design decisions that must be made. Figure 1 shows a flowchart that presents the key steps in the performance-based design process. It is an iterative process that begins with the selection of performance objectives, followed by the development of a preliminary design, an assessment as to whether or not the design meets the performance objectives, and finally redesign and reassessment, if required, until the desired performance level is achieved. [2].

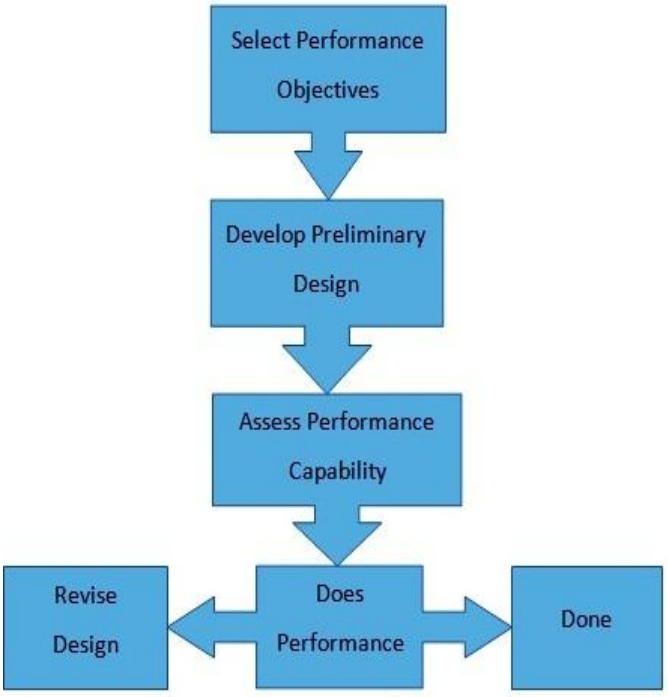

Fig.1 Performance based design

II. LITERATURE REVIEW

A. D.N.Shinde, Nair Veena V, Pudale Yojana M, "PUSHOVER ANALYSIS OF MULTI STORY BUILDING " INTERNATIONAL JOURNAL IN RESEARCH IN ENGINEERING AND TECHNOLOGY, VOL. 3, SPECIAL ISSUE 3, MAY 2014

D.N.Shinde, Nair Veena V, Pudale Yojana M "Pushover Analysis of Multi Story Building". The paper overviewed about the seismic response of RC building frame in terms of performance and the effect of earthquake forces on multi storied building frame with the help of pushover analysis.

In this a building frame is designed by the author as per Indian standard i.e. IS 456:2000 and IS 1893:2002. The main objective of this study was to check performance of building when designed as per Indian Standards. The pushover analysis of the building frame was carried out using structural analysis and design software SAP 2000.

For obtaining performance point a building frame of G+10 floors was considered. It consisted of two bays in both the directions. The spacing along X and Y directions were 5m and the storied height was taken as 3m. The frame was located in seismic zone III.

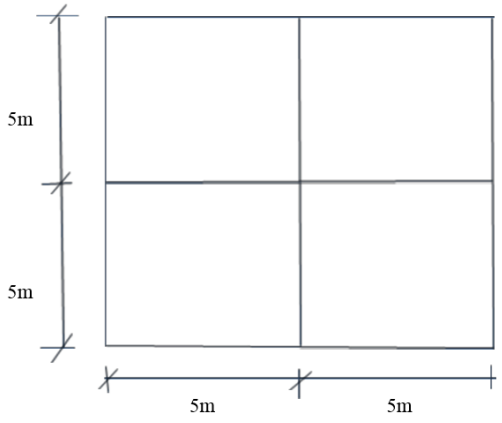

Fig 2 Plan of building frame

In this paper for obtaining the performance point of the building frame in terms of base shear the design base shear was

calculated for the safety of the frame. The design base shear was calculated as per IS: 1893:2002.
Vb = 720 KN

In these paper for pushover analysis the various pushover cases were considered such as push gravity, push X (i.e. loads are applied in X direction), push Y (i.e. loads are applied in Y direction). The various load combinations were also used

for this purpose. After pushover analysis the demand curve and capacity curves were obtained to get the performance point of the structure. The performance point was obtained as per ATC 40 capacity spectrum method. The base shear for PUSH X load case was (904.612 KN). And for PUSH Y base shear at performance point was (915.197) as shown in figure.3 AND 4.

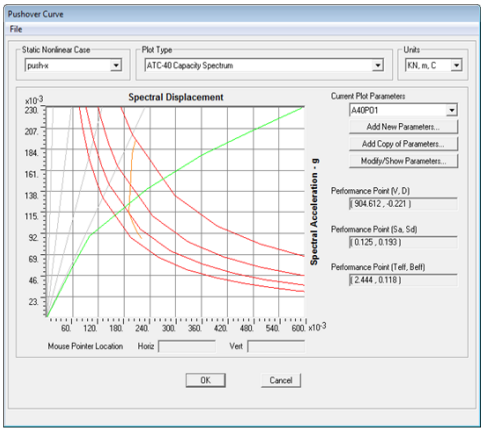

Fig.3 Capacity and demand curves for PUSH X load case

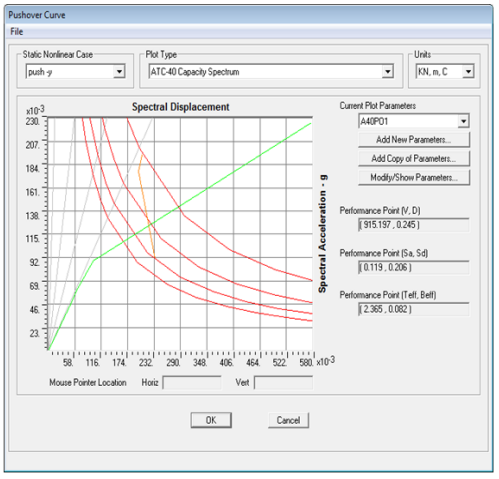

Fig.4 Capacity and demand curves for PUSH Y load case

They had concluded that the Building designed with IS 1893:2002 have a better performance during earthquake. The design base shear of the building frame was found to be 720 KN as per calculation. After analysis, the base shear was found to be 915KN which was greater than designed base shear. Hence, the base shear was greater than the designed base shear and the building frame was safe during natural calamities like EQ.

B. DIMPLEBEN P. SONWANE, PROF.DR.KIRAN B. LADHANE, "SEISMIC PERFORMANCE BASED DESIGN OF REINFORCED CONCRETE BUILDING USING NONLINEAR PUSHOVER ANALYSIS", IJ ERT JO URNAL, JUNE 2015, VOL. 4, ISSUE 6

Dimpleben P. Sonwane, Prof.Dr.Kiran B. Ladhane "Seismic Performance based Design of Reinforced Concrete Building using

Nonlinear Pushover Analysis". The author presents an effective computer based technique that incorporates pushover analysis together with pushover drift performance design of RC buildings. The study begins with the selection of performance objectives, followed by development of preliminary design, assessment whether design meets performance objectives or not, finally re-design and reassessment if required, until the desired performance level is achieved.
In this RC framed building example (Designed according to IS 456:2000) analysed using pushover analysis and redesigning by changing the main reinforcement of various frame elevations at different storey level and analysing. The pushover analysis has been carried out using SAP 2000, product of computers and structures international. The building is considered as special moment resisting framed building and the main objective of this is to check performance of building when designed as per IS. The best possible combination of reinforcement is economical, effective and having minimum damage to enable immediate occupancy determined and termed as performance based design.

C. DR. REHAN A. KHAN "PERFORMANCE BASED SEISMIC DESIGN OF REINFORCED CONCRETE BUILDING", IJIRSET , VOL. 3, ISSUE 6, JUNE 2014

Dr. Rehan A. Khan "Performance Based Seismic Design of Reinforced Concrete Building". The present study is an effort to understand Performance Based Design Approach. In this, a five storeyed symmetrical building is designed using STAAD. Pro and the performance based seismic design is performed by N2 method using a simple computer-based pushover analysis technique using SAP2000, a product of Computers and Structures International.

This procedure compares the capacity of the structure (in the form of a pushover curve) of a MDOF system with demands on the structure (in the form of inelastic response spectra of a single degree freedom system). This method is formulated in acceleration displacement format. The graphical intersection of the two curves approximates the performance point of the structure.

The proposed method is illustrated by finding the seismic performance point for a five storeyed reinforced concrete framed building located in Zone-IV, symmetrical in plan (designed according to IS 456:2002) subjected to three different PGA levels as input ground motion. An extensive parametric study is conducted to investigate the effect of many important parameters. The parameters include effect of input ground motion on performance point, changing percentage of reinforcement in columns, size of columns, beams individually. The results of analysis are compared in terms of base shear and storey displacements.

D. RAJESH M N, S K PRASAD "SEISMIC PERFORMANCE STUDY ON RC WALL BUILDING FROM PUSHOVER ANALYSIS", IJRET, VOL. 3, SPECIAL ISSUE 6, MAY 2014

Rajesh M N, S K Prasad "Seismic Performance Study on RC Wall Building from Pushover Analysis". In this paper, RC walls are modeled and analyzed using SAP 2000's pushover analysis capability on layered shell elements. Various parameters such as aspect ratio of walls, reinforcement detailing aspects and presence of openings are selected to study the seismic performance of RC walled buildings. Results of analysis have revealed that incorporation of ductile detailing in the form of boundary element significantly improves the seismic performance of RC walls, specially the displacement ductility of the wall and the effects which are more pronounced when the bottom storeys are strengthened with boundary elements. Presence of openings in RC walls significantly reduces base shear carrying capacity in the presence of boundary elements while it reduces both base shear capacity and ductility in the absence of boundary elements. Decrease in the aspect ratio of the wall reduces the base shear capacity of the wall while deformation capacity remains unaffected.

III. CONCLUSION

From the above literature we conclude that:
1) Pushover analysis is a simple way to investigate nonlinear behavior of the building.
2) Building design with IS: 1893: 2002 gives better performance under given EQ.
3) Pushover analysis is an elegant tool to visualize the performance level of the building.
4) If we increase the size of the column & beam that time roof displacement decrease and base shear increase as wice varsa.

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