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Pushover Analysis Of Existing RC Frame Structure

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Abstract:

The pushover analysis of a structure is a static non-linear analysis under permanent vertical loads and gradually increasing lateral loads. The equivalent static lateral loads approximately represent earthquake induced forces. Seismic analysis of building can be categorized depending upon the sophistication of modeling adopted for the analysis, but in this method one would not be able to capture the dynamic response, especially the higher mode effects. The capacity of structure is represented by pushover curve. The method of Pushover analysis is to observe the successive damage states of a building. this method is relatively simple to be implemented and provides information on strength and deformation and ductility of the structure and distribution of demands which help in identifying the critical member likely to reach limit states during the earthquake and hence proper attention can be given while design and detailing. Modeling for such analysis requires the nonlinear properties of each component in the structure of the determination, quantified by strength and deformation capacities, which depend on modeling assumption . In this building frame is designed as per Indian standard i.e. IS-456:2000 and IS-1893:2002 and IS-875:1987. The study of the main objective to check performance of building when designed as per Indian Standard. The structural engineering profession has been using the nonlinear static procedure or pushover analysis described in FEMA-356 and ATC-40, when pushover analysis is used carefully it provides useful information that cannot be obtained by linear static or dynamic analysis procedure. The reinforced concrete structure are analyzed by nonlinear static analysis (Pushover analysis) .Using structural analysis and design ETABS 2016 Software. the present study is to evaluate the behavior of two typical new R.C.C building were taken for analysis G+8 and G+12 floors reinforced concrete frame structure subjected to earthquake forces in Zone II. The paper gives the study of different literature investigation taken on pushover analysis.

Keywords
Pushover analysis , Response spectrum , Base shear , Displacement , performance based design.

1. Introduction

The static pushover analysis is becoming a popular tool for seismic performance evolution of existing and new structures. Earthquake is known to be one of the most destructive phenomenon experienced on earth . It is caused due to a sudden release of energy in the earth's crust which results in seismic waves. When the seismic waves reach the foundation level of the structure, it experiences horizontal and vertical motion at ground surface level. Due to this, earthquake is responsible for the damage to various man-made structures like buildings, bridges, roads, dams, etc. It also causes landslides, liquefaction, slope-instability and overall loss of life and property the expectation is that the pushover analysis will provide adequate information on seismic demands imposed by the design ground motion on the structural system and its components. the pushover analysis of a structure is static non-linear analysis under permanent vertical loads and gradually increasing lateral loads the equivalent static lateral loads approximately represent earthquake induced forces. the capacity of structure is represented by pushover curve. the most convenient way to plot he load deformation curve is by tracking the bas shear and the roof displacement. amongst the natural hazards, earthquakes have the potential for causing the greatest damages. since earthquake forces are random in nature & unpredictable ,earthquake loads are to be carefully modeled so as to assess the real behavior 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 procedure the promise of performance

based seismic engineering (PBSE) is to produce structure with predictable seismic performance .the identifying and assessing performance capability of a building is an integral part of the design process. the design decision that must be made .In the case of non-linear inelastic dynamic time-history analysis ,there is a big space in the qualitative comprehension of the response history of the system as well as difficulties in verification of results. Pushover analysis uses lateral external static forces at floor levels in combination with inelastic response spectra , and that avoids the rigorous non-linear inelastic dynamic time history analysis . in order to be able to use inelastic response spectra for the case of multi degree system, a suitable nonlinear equivalent single degree of freedom system must first be defined. the calculated inelastic dynamic response is quite sensitive to the characteristics of the input motion ,thus the selection of a suite of representative acceleration time histories is mandatory. the technique may be also used to highlight potential weak areas in the structure. The earthquake recording were carefully completed so as to reflect characteristics of normal far-fault records and typical near-fault records having forward directly and fling effects.

2. Objective Of Study

To study seismic behavior of structure.

To study seismic analysis and design of structure.

To study performance based design (Pushover analysis).

To study the nonlinear behavior of structure.

To study the effect on nonlinear capacity of structure due to design based on loading.

3. Problem Formulation

RCC Frames with G+8 and G+12 have been considered in the study. Fundamental period of vibration of the frame with fixed support .In this building frame is designed as per Indian standard i.e. IS-456:2000 and IS-1893:2002 and IS-875:1987 and model analysis has been evaluated. In order to understand the effect of pushover analysis of existing RC frame structure base model using ETABS 2016. Response spectrum method and Pushover analysis of analysis of the models are performed using ETABS 2016 .

1.1 Models

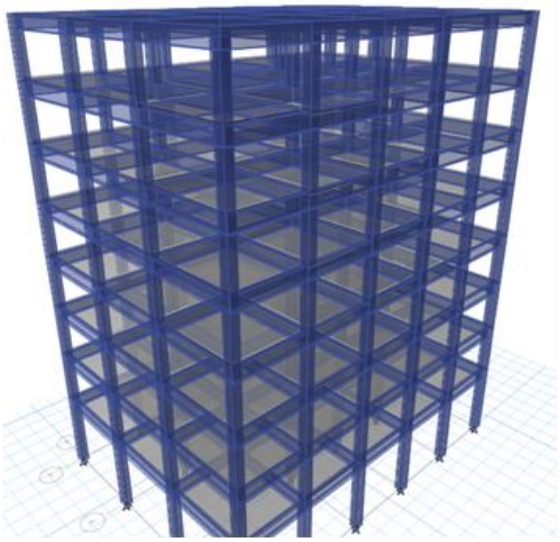


Fig.1. Model:1 G+8 Storey RCC Frame Building.

1.1 Data for All Models

Table1. Gravity loads Assigned to RC Building.

No. of stories	G+8
Floor to Floor Height	3000 mm
Beam size	450*300 mm
Column size:	450*450 mm
Thickness of slab	150 mm
Density of concrete	25kN/m^3
Soil Type	Medium

Zone Factor(Z)	0.36
Important factor(I)	1
Response reduction factor(R)	5
Grade of Concrete	M25 and M30
Grade of Steel	Fe415

4. Performance Based Design

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.

These is a major shift from traditional structural design concepts and represents the future of earthquake engineering. This provides procedure a method for determining acceptable levels of earthquake damage. Also, it is based on the recognition that yielding does not constitute failure and that preplanned yielding of certain members of a structure during an earthquake can actually help to save the rest of the structure.

5. Static Non-Linear Analysis

In performance based design response of structure is considered beyond elastic limit as opposed to code based approach. Static non-linear analysis is one of the analysis technique used for performance based design. Two types of pushover analysis are as:

Force controlled

Used when load is known and structure is desired to support this load. For gravity load on structure force controlled, push over analysis is used.

Displacement controlled

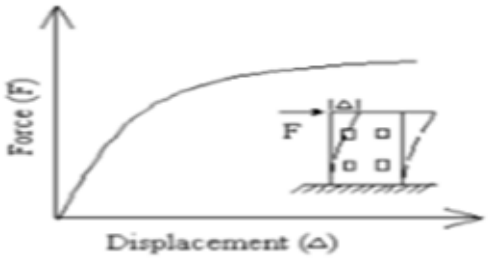
Used when load is unknown but displacement is known and structure is desired to lose their strength and become unstable. For lateral load on structure displacement controlled, pushover analysis is used.

Three main steps involved in this analysis procedure.

1. Evaluation of Capacity of building i.e. Representation of the structure's ability to resist a force.
2. Evaluation of Demand curve i.e. Representation of earthquake ground motion.
3. Determination of Performance point i.e. Intersection point of demand curve and capacity.

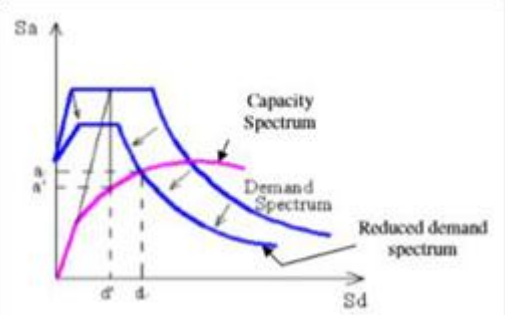
Capacity

The increasing lateral displacement as a function of the simplified non-linear procedure is followed for the generation of the capacity curve.



Demand

Spectral Acceleration (Sa) versus Time Period (T) curve is given in IS:1893(Part1)-2002 which is converted in to Spectral Acceleration (Sa) versus Spectral Displacement (Sd) curve. The Capacity curve and Demand curve are generated in spectral coordinates to find out performance point.



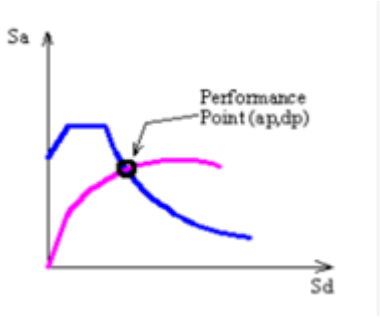
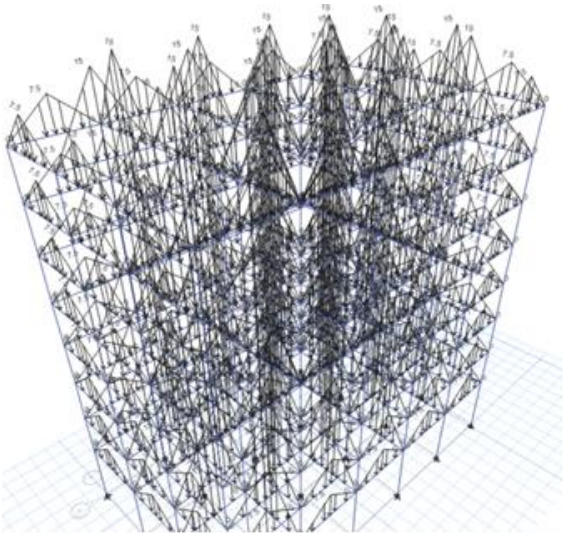


Fig. Performance Point

Performance

The intersection of the pushover capacity and demand spectrum curves defines as the "performance point" as shown in fig.

Selection for G+8 Storey Rectangular Shape Building From Paper Mwafy (2000).



6. Litrature Review

Mwafy A.M , Elnashai A.S [2000]

The response of a 12-storeyed rc frame structure the validity and the applicability of this technique are assessed by comparison with dynamic pushover idolized envelops obtained from incremental dynamic collapse analysis. This is undertaken using natural and artificial earthquake records imposed on 12 rc Building of different characteristics .Good correlation is obtained between the calculated idealized envelops of the dynamic analysis and static pushover results for a defined class of structure Proper understanding of the dynamic pushover envelops and compare these with the static pushover results with different load patterns needs to be studied in details before designing.

The seismic response of rc building are investigated in predicting .applicability and accuracy of inelastic static pushover analysis .The 12 rc frame building with various characteristics ,incremental dynamic analysis and artificial records ,the using three lateral load distribution for static pushover analysis and local and the utilized for global limit state criteria .Based on the large amount of information obtained. Which is nonetheless far from comprehensive .The conclusion drawn are following manner.

Pushover analysis can provide insight into the elastic as well as when the subjected to earthquake ground motion for the inelastic response of building. In this study response obtained for a group of four 8-storey irregular frame building using an inverted triangular lateral load distribution is identical to inelastic time history analysis. For well designed building but with structural irregularities the results of the procedure also show good correlation with the dynamic analysis. The knowledge and experience gained from previous studies can help to eliminate the discrepancies between static and dynamic analysis result for special and long period .

The demands of some building in the elastic range. Apply the uniform load provides a conservative prediction of seismic demands in the range before first collapse . it also yield an acceptable estimation of shear demands at the collapse limit state.

Kalkan erol , Kunnath sakshi [2006]

The accurate estimation of seismic demands parameters for an essential and critical component of evolving performance based design methodologies. The currently widely nonlinear static procedure is used in engineering practice seismic demands in building structure. These seismic demands using NSP can be computed directly from a site specific hazard spectrum, just like a nonlinear time-history (NTH) analyses require ground motion ensemble and the aleatoric variability in earthquake recording. Consequently a number of enhanced pushover procedures that overcome many of these drawbacks have also been proposed.

The investigate the effectiveness of several NSP in predicting the salient response characteristics of typical steel and reinforced concrete building through comparison with benchmark responses obtained from a comprehensive set of NTH analyses. The most important an array of time series from ordinary far-fault records to near fault motion having fling and forward directivity effects was employed, to consider diverse ground motion characteristics the final result from the analytical study indicate that the adaptive modal combination procedure predicted peak response measure such as inter story drift and

component plastic rotation more consistency that the other NSP investigated in the study.

The FEMA-356 method provides inadequate prediction of peak member plastic and peak understory drift rotation at the upper story levels when higher mode contribution are significant.

The poorest by far were UBPA estimates, being unable to reasonably predict even the peak displacement profile the peak displacement profile the member rotation at the lower levels and to their overestimation at the upper stories.

Valente Marco [2013]

The numerical investigation carried on a new alternative dissipative bracing system for improving the seismic performance of r/c frames .the proposed system is composed of ductile shear panel and concentric x-braces and can be used to provide both ductility and stiffness to existing structure. The braces are expected to remain elastic for under seismic action, while panel dissipates significant amount of energy by yielding.

A simplified model of the bracing system is developed for global analysis of frames an energy based design procedure for concentric X-braces is presented and seismic upgrading of frames with ductile shear panel. this simplified procedure the based on nonlinear static analysis and energy balance energy, the design stage and can represent an advantageous approach preliminary analysis .results of nonlinear dynamic analyses performed on a four storey R/C frame designed only for gravity loads show that the proposed bracing system can protect the primary structural elements of the frame preventing them from under severe seismic action.

A simplified model of the bracing system was developed for global analyses of multistory building frames. The effects of the application the seismic response of the multi story R/C frame were assessed on the dissipative bracing system. The method was able to achieve the target displacement satisfactorily and was validated against earthquake records. The proposed procedure was that it's provided a simple solution for obtaining a design of the BDSP system. The seismic performance improvement of R/C frames designed only for gravity loads was investigated through numerical analysis the BDSP system was applied to the seismic upgrading of a storey non-ductile R/C frame structure. The results of the numerical investigation showed a considerable reduction of the maximum top displacement in case of frames protected by the BDSP system. The structural elements were significantly reduced in case of severe seismic action by the energy dissipated. The preventing development of a soft-story mechanism at the third floor. And a more uniform distribution of inter storey drift was observed for the projected by R/C frame. The reducing plastic demand on the structural members of the third party and along with the potential for structural damage, the energy dissipation concentrated in the ductile shear panels and resulted uniform over the height of the frame.

Safarizki Hendramawat , Kristiawan A.S , Basuki.A [2013]

The used of steel bracing as like a evaluate the possible improvement of seismic performance of existing reinforced concrete building. The employed for the purpose of the study are three method of seismic evolution i.e. nonlinear static pushover displacement coefficient method as described in FEMA 356 .Improvement of nonlinear static pushover displacement coefficient method as described in FEMA-440. And dynamic time history analysis following the Indonesian code of seismic resistance building criteria. the performance of the building could be categorized in between life safety – collapse prevention and the plastic hinges occur in columns .the serviceability lime criterion when the recorded EI Centro acclerogram was used for dynamic time history analysis exceed indicated that the story drifts in y direction .

The performance of the existing building could be improved if steel bracing are utilized for seismic retrofitting. Furthermore dynamic time history analysis point out that the story drifts of the retrofitted building are within the limit criteria .the seismic performance of retrofitted building the size of steel bracing elements do not significantly affect. Steel bracing could be utilized for seismic retrofitting of the 5 the building of UNS engineering faculty. This study does not clearly show the effect of steel bracing sixe in improving seismic performance of the structure under consideration. The dynamic time-history analysis conform this and both nonlinear static pushover analysis based on FEMA 356 and FEMA 440.

Ghobarah Ahmed [2001]

In the current building code address life safety for design objectives , moderate earthquake and control damage is minor and prevent collapse in a major earthquake the design in achieving the objectives is not known .The professional that future seismic design needs to be on achieving stated multiple performance objectives and there is a general agreement among researchers .future seismic design practice will be based on explicit performance criteria that can be quantified, considering multiplying performance and hazard levels.

There are several challenges to be addressed before procedure for performance criteria that can be

quantified, considering multiple performance and hazard levels.

The development in performance based design in seismic engineering will be directed towards the definition of performance objectives, the general design methodology, issues of ground motion modeling and the demands and capacity evaluations.

There is general agreement that future seismic design needs to be based on defined multiple performance objectives and associated earthquake hazard levels the possibility of achieving predictable seismic performance with uniform risk for advantage of performance based design. the response parameters which can be calculated such as stress , strain ,displacement ,acceleration and their derivatives the reliability of the approach may ultimately depend on the development of explicit and quantifiable performance criteria that can be related. the developments in performance based design in seismic engineering will be directed towards a general design methodology that permits performance based design at multiple performance and hazard level and with due consideration given to the complete soil foundation structure system ,nonstructural system and the building contents and components. The framework for a unified seismic design approach could be based on performance based design concepts for multiple performance levels .However much research to be done before such a design methodology can be implemented.

Poursha and Khoshnoudian et al. [2008]

The Nonlinear static procedure is restricted to single mode response .the represent of a new pushover procedure of the effects is higher mode which can rake into account. The final structural responses are determined by enveloping the result of single stage and multi stage of pushover analyses. The applied process to four special steel moment resisting frames with different heights. The comparison between estimates from the CMP procedure the value is exact obtained but nonlinear response history. The CMP process is able to effectively overcome the limitations of traditional pushover analysis the seismic demands tall building it is therefore valid for low-rise building .

The consecutive model pushover procedure has been proposed. The employs multi-stage and single-stage pushover analysis .the single stage pushover analysis is performed with a uniform load distribution or triangular .the seismic demands in mid and upper storey. Using consecutive modal pushover procedure the storey drift can be e4stimate with accept accuracy .the storey drift are more accurate estimate by the CMP than by the MPA.A significance improvement has been achieved in estimate the hinge plastic rotation through the CMP procedure. The improvement in the CMP procedure results from the consecutive implementation of modal pushover analyses. The height wise distribution of the hinge plastic produced by the CMP procedure the more similar to that by the MPA procedure. The CMP procedure is more accurate than the FEMA load distribution in predicting the seismic demands of tall building. It should be verified for different lateral force resisting system and a variety of ground motion sets. The work in this area is underway.

Valente [2013]

The investigate a new type of friction damper for improving the seismic performance of precast concrete frame structure .the hysteretic behavior of the friction was developed and the parametric analysis were carried out in order to establish the optimum value of the slip force of the device was numerically assessed on different typologies of precast structure by performing nonlinear dynamic analysis .the mainly used for friction damper externally at selected beam to column joints of the frame to dissipate energy during severe earthquake .the device of plastic deformation concentrated inside the device ,severe damage from columns are protecting .the increase of moderate base shear was observed for the building protect by friction device.

In this result was conclusion that effect of the application of friction devices on the seismic behavior of the existing precast frame structure were investigated in this study .the detailed numerical models of different precast frame structure incorporating friction devices were developed and analyzed under seismic action. In this case of high intensity levels earthquake are effects were more evident. the column base was delayed by the insertion of the friction devices with respect to the bare structure for the formation of the plastic hinges .the dissipative capacity of the building and a reduction of displacement and deformation demand for the column in between the introduction of such a friction device caused an increase . The improving the seismic performance of precast building using dissipative devices to a moderate increase of the base shear was observed for the building with friction devices

Chandler Adrian , Lam Nelson [2001]

The reviews based on performance based design for the contribution of research towards the development of the methodologies associate with performance based seismic engineering the research undertaken in various related disciplines is reviewed , under the broad section heading of 1) Engineering seismology and geology (modeling for seismic activity) 2) Engineering seismology (Modeling for

seismic hazard),3) mechanics of material (As example of concrete used) 4) Soil dynamics 5) System dynamics .

The discussion in consistent with a typical seismic assessment procedure ,which commences with seismic activity modeling in the two procedure are divided upstream and downstream .the upstream is end of the procedure finishes with consideration of structural mechanics behavior at the downstream end. An outline of historical research and development, leading to a review of the art approaches. The inner-linking of the disciplines is given to particular emphasis; the research paper refers to such link as "Nodal Points". the nodal points associated with the various disciplines has been critically reviewed , and shortcoming have been certified .

A review of the problems at these links sows the seeds for further development the individual disciplines within would not have been possible had all the recent contribution been confined. The paper brings to light the fact that, although significant achievement have been made in each of the related disciplines and the nodal points is connected. At the nodal points has been relatively little change in substance.

The highlighted a large number of key issues related to the application of PBSE, two are particular unifying importance.The current format of using probalistic seismic hazard coefficients (PSHC) to define earthquake hazard does not directly address the physical process of an earthquake event, it is very restrictive for future developments in PBSE. the determination of cumulative residual drift cannot be achieved without direct reference to the demand history of an individual earthquake design event. The currently widely most of the uses seismic hazard coefficients.

The associated UHS are based on a structure responding with a unique natural period. It is increasingly understood that the structure period can be very hard to determine and is shaking non-unique under severe ground shaking.

The importance of the maximum considered for credible earthquake and of distant earthquake has not been adequately addressed by current seismic hazard are modeling procedure, and low and moderate seismicity regions.

The authors preferred approach of working with a specific set of pseudo-probabilistic earthquake M-R combination in seismic assessment using PBSE. the paper present has consistently highlighted these aspects and has presented suggestions for revising current thinking linked to someone what outdated 'Nodal Points' to better reflect the increased understanding of key issues and to move towards more logical approaches to seismic performance assessment .thus ,contributors from different background must keep abreast of the latest development in all related fields of interest, in order to co-direct all further developments towards the objective of a fully integrated and is research of the effective system .

Triantafyllos K. Makarios [2005]

The optimum definition of an equivalent non-linear signal degree of freedom system, which substitutes for a multistory plane reinforced concrete frame is presented. this optimum definition of a non-linear SDF system is derived mathematically, for the special case of dynamic loading on masses of the multistory frame , using suitable simplified assumption .this optimum non-linear SDF system is suitable for use in approximately non-linear procedure such as static pushover analysis , in order to estimate the seismic demands of multistory plane R/C frames .the case of ground motion 9seismic excitation) at the base of multistory plane frame as the result of the system by applying this nonlinear SDF system in a series of multistory plane R/C frames are verified by non-linear inelastic dynamic time-history analysis using the drain -2D program .

The numerical example of a nine-story plane R/C frame is given. Although non-linear direct inelastic dynamic time-history analysis is the most suitable method for estimate of seismic demands of structure, due to its high computational costs, civil engineers often prefer to use the pushover analysis, at least by the first method applied totally. Also it is known the approximate methods , which use an Equivalent elastic linear SDF system with secant-stiffness Ksec and equivalent , viscous damping ration T eq >> 0.05 for R/C Structure , do not predict correctly the maximum demands inelastic displacement the system has been calculated approximately using a known inelastic response spectra, the demand ductility u , the yield strength reduction factor Ry and the equivalent viscous damping ratio Teq =0.05 on the other hand it is known that various equivalent DSF system , which had been proposed in the past for the pushover procedure, give the acceptable result only for special R/C Frame that had been examined, while for other r/c frames, the definition of the SDF system is still an issue open to question. Indeed, the international scientific community has not agreed on a unique procedure of the definition of an equivalent SDF system, while the present paper has come to fill exactly this space... optimum definition an equivalent non-linear single – degree of freedom SDF system , corresponding to a multistory R/C plane frame has been presented.

This is suitable for optimum linear SDF system approximate non-linear procedure, in order to estimate the seismic demands of R/C frames because

it is mathematically documented, since it results for the special case of dynamic loading on masses of a general of plane multistory model, using suitable simplified assumption. the optimum system possess the horizontal displacement Un also, it possess an equivalent mass m that is given by eq as a function of not only the vectors Φ of the maximum inelastic displacement of floors but also the vector Y of distribution of lateral static forces of floors but also from the pushover procedure.

Dadi and Agrawal [2015]

The nonlinear performance of RC beam specimens under flexural are evaluated with constant % of thermo mechanically treated (TMT) reinforcement in confined and unconfined by pushover and cyclic loading .the specimens of beam under cyclic testing have show large yield strength but low ductility as compared to pushover testing .which is synonymously used without the relevance either of monotonic or cyclic load of a component or a structure, the confining of transverse reinforcement is another significant parameter on which the deformation of post yield relationship and an RC component depend on resulting ductility.

The show by eight beam specimens are evaluated under pushover loading and cyclic loading in confined and unconfined condition. The experimentally obtained plastic rotation parameters are the values prescribed compared with in ASCE/SEI41-06 .The main findings of the study are as follows .the non-modeling parameter "a" obtained from pushover testing is significantly larger than the values obtained from cyclic test the ratio values of an "a" from pushover to cyclic is approximate corresponding beam specimen in TMT/G1 and TMT/G2 respectively. The values of non-linear modeling parameters "a" obtained from cyclic test are closer to the maximum values prescribed by the ASCE/SEI 41-06 respectively. It may be concluded that the modeling parameter values must be based on cyclic test rather than pushover test. The pushover testing of beam specimens under unconfined condition.

Yasuto Nakamura, Hossein Derakhshan et.al [2016]

The nonlinear static procedure for low rise unreinforced masonry building with flexible diaphragms this applicability method. there are two method are investigating for estimating the peak seismic response of unreinforced masonry buildings with flexible diaphragms first one is modal pushover analysis (MPA) and an adaptive pushover analysis method.

The performance based seismic assessment of a building is the prediction of the peak inelastic seismic response of the building subjected to a predetermined level of earthquake shaking .the nonlinear static procedure are compared against nonlinear time history analysis of three low wise building models with various levels of stiffness eccentricity type of failure mechanism of piers (rocking and shear) and a range of diaphragm stiffness representing timber floor and roof system .the results indicate that the MPA is unsuitable for unreinforced masonry building with flexible diaphragms , if the response building is shear dominated when the diaphragms was relatively flexible , none of these methods can provide accurate prediction of peak seismic demands . taking the envelope of pushover analysis carried out using the force distribution proportional to the uniform and linear displacement shapes along the height of the building . the modal combination rule used in the MPA, for unreinforced masonry building with flexible diaphragms.

Paolo Foraboschi

The reinforced concrete building of the postwar rebuilding and the versatility of steel in correcting construction deficiencies and in seismic retrofitting of RC building. the building represented a typical RC framed structure of the 1960s . Although not being a listed building , the edifice was of interest and importance , since it was of good quality design and appear

7. Conclusion

There are good reason for advocating the use of the inelastic pushover analysis for demand prediction ,since in many cases it will provide much more relevant information that an elastic static or even dynamic analysis ,but it would be counterproductive to advocate this method as a general solution technique for all cases .

The pushover analysis is a useful, but not in fallible ,tool for accessing inelastic strength and deformation demands and for exposing design weakness.

The force and deformation demands and capacities that control seismic response close to failure, but it needs to be

recognized that in some cases it may be provide a false filling of security if its shortcomings and pitfalls are not recognized .

The performance of pushover analysis primarily depends upon choice of material models included in the study.

Static pushover analysis is more appropriate for low rise and short period frame structure .for well designed building but the structural irregularities the

result of the procedure also show good correlation with the dynamic analysis .

The result of dynamic collapse analysis show clearly that each earthquake record exhibits its own peculiarities , dictated by frequency content duration sequence of peak and their amplitude..

The importance of pushover analysis as an assessment and design tool warrants much needed further development.

In this study ,after the pushover analysis the hinges were found one column which shows the structure is seismically in safe. the provision bracing in thee ground storey increases the stiffness of the structure and reduces the displacement is proved in the pushover analysis .the performance of the in filled reinforced concrete frame has enhanced due to the provision of bracing in the open ground storey.

The seismic performance of the frame can be considerably enhanced by the inclusion of friction damper in the structural system. The dissipation characteristics of the friction damper are reliable and the devices are not damaged by large loads. By confining the energy dissipation to the friction damper which are specifically designed to perform under extreme loading conditions without sustaining damage, the main structural elements are able to remain elastic. The device provides a significant increase in the available damping within the structure and that leads to a direct improvement in performance.

The Capacity of seismic load and gravity load are checked.

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