



Pushover Analysis of Steel Frame Structures with Base Isolation Devices

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ABSTRACT

Pushover analysis has been widely used for seismic assessment of buildings as it's a nonlinear, static technique used to estimate deformations in a structure due to seismic force. In past years pushover analysis has accomplished majority of importance because of it being simple to perform and giving effective results. The main result of a pushover analysis is the capacity curve which is a force-displacement relation, involving the load to be applied incrementally until the structure collapses. The seismic performance of the buildings can be enhanced by using various base isolation devices, such as HDRB, LRB and LDRB.

This research work aims to explore the applicability of these devices in tall buildings. To achieve this purpose storey numbers ranging from 3 to 15 with a step size of 3 storeys have been modelled and analysed with inclusion of different types of damping devices to evaluate their feasibility in this model. Finally effect of inclusion of base isolation with its effect on different storeys have been evaluated and some useful outcomes and recommendations for effective seismic design have been presented from this analysis. The structures are designed accordance with Indian Standard, i.e. IS 800:2007 and the pushover analysis has been done using structural analysis and design software STAAD pro.

Keywords: Base isolation devices, Capacity curve, Critical damping, Dislocation, Earthquake resistant structures, Hinge-FEMA, Linear elastic, Non-linear static, Pushover analysis, Seismic isolator, Storey drift.

Abbreviations: HDRB, high density rubber bearing; LRB, lead rubber bearing; LDRB, low density rubber bearing.

1. INTRODUCTION

Push-over analysis is the favoured technique for seismic presentation assessment of configuration by the main psychoanalysis strategies and system since it is accurate on the basis calculation and perception. Pushover examination permits tracing the succession of acquiescent and collapse on component and building height as well as the improvement of general competence bend of the structure. The anticipation from push-over examination is to approximate decisive comeback constraint forced on structural classification and its mechanism as secure as potential to those calculated by nonlinear vibrant examination. The information regarding the response features are provided using

the pushover analysis which are not provided by elastically static examination or elastically dynamic examination.

The base isolation procedure is a seismic intend move towards in which because of the inclusion of a stretchy coating sandwiched between the groundwork and the superstructure the basic occurrence of the arrangement reduces to an importance inferior than the major force including frequencies of tremor earth movement. The isolators are not mainly acting to assimilate the vitality of the quake, however are giving an interface that responds tremor vitality over into the ground so diminishing its transmission into the structure. Additionally the capacity of damping which is provided usually by damping system helps in dispersing the power conveying while the occurrence of seismic activities. The impact

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Insights Into Pushover Analysis Results for Steel Moment Resisting Frames at Sites with Varying Seismic Demands Natalia Ricci,2015 This project presents the design process for a special steel moment frame located at three sites that have different seismic demands All the designs are code compliant and some of the code requirements are illustrated Once the structural elements are selected SAP2000 is used to model the moment frames and to run a pushover analysis This is an accurate analysis that accounts for material and geometrical nonlinearities and provides a force displacement curve that allows the designer to determine the collapse loads and the maximum displacement for each of the moment frames In addition the pushover analysis provides an insight into the weak links of the moment frames showing the progression of plastic hinge formation At the end results for the designs are compared and reserve strength and ductility capacities are calculated **"Static Pushover Analysis of Moment Resisting Steel Frames Using DRAIN-3DX"** James McCrum,2003

Inelastic Performance and Economical Assessment of Concentrically Braced Steel Frames by Nonlinear Static (Pushover) Analysis Arash Farzam,Doğu Akdeniz Üniversitesi,2009 ABSTRACT Concentric bracing system is one of the most economical systems being used to provide lateral stability for steel structures during earthquake by inelastic behavior Although inelastic response of structures is affected by their height and structural system these issues are not considered for the design of concentrically braced frames CBFs in the current design codes The previous research work on the economical comparison of steel bracing systems has compared their elastic response only regardless of their plastic range This work is aimed to study the inelastic behaviors and compare the weights of different CBFs X V Inverted V and Diagonal braced frames in order to supply comprehensive information for design procedures Inelastic responses of the 4 8 and 12 story X V Inverted V and Diagonal braced frames were assessed by the nonlinear static pushover analysis mainly based on FEMA 440 2005 A new methodology was proposed for the economical comparison of the frames subtracting the weight of a benchmark frame from the frame weights to calculate the pure bracing system weight to overcome the inaccuracy of the procedures being used by the previous studies using the total frame weight instead of the bracing system weight By conducting pushover analysis it was found that the failure progress of all the frames was mainly due to the buckling of compression bracing members but with some differences due to story height and frame type Diagonal Inverted V X and V braced frames generally have the highest to the lowest initial elastic and post yield stiffness respectively The changes in nonlinear responses of the frames due to the changes in the story height follow special and predictable rules and are generally has less effective on the results than the frame type V braced frame was found to have the highest target displacement point V Inverted V X and Diagonal braced frames were found to be in order the lightest to the heaviest systems The available economical comparison methodology for the bracing system was found to seriously undermine the differences among the results of the comparison whilst the methodology proposed in this work was observed to give more reliable results By estimating the energy dissipation per

weight of all frames from the obtained results it was observed that Inverted V bracing system is the most efficient type for 4 story frames V bracing system is the most efficient for 12 story frames X and Diagonal bracing systems are the third and fourth efficient bracing systems respectively

Advanced Analysis of Steel Frames W.F. Chen, 2018-01-18 The development of the limit state approach to design in recent years has focused particular attention on two basic requirements accurate information regarding the behavior of structures throughout the entire range of loading up to the ultimate strength and simple practical procedures to enable engineers to assess this behavior This book satisfies these requirements by providing practical analysis methods for the design of steel frames The book contains a wide range of second order analyses from elastic to inelastic rigid to semi rigid connections and simple plastic hinge method to sophisticated plastic zone method Computer programs for each analysis are provided in the form of a floppy disk for easy implementation Sample problems are described and user s manuals are well documented for each program developed in the book

Advanced Analysis and Design of Steel Frames Gou-Qiang Li, Jin-Jin Li, 2007-06-13 Steel frames are used in many commercial high rise buildings as well as industrial structures such as ore mines and oilrigs Enabling construction of ever lighter and safer structures steel frames have become an important topic for engineers This book split into two parts covering advanced analysis and advanced design of steel frames guides the reader from a broad array of frame elements through to advanced design methods such as deterministic reliability and system reliability design approaches This book connects reliability evaluation of structural systems to advanced analysis of steel frames and ensures that the steel frame design described is founded on system reliability Important features of the this book include fundamental equations governing the elastic and elasto plastic equilibrium of beam sheer beam column joint panel and brace elements for steel frames analysis of elastic buckling elasto plastic capacity and earthquake excited behaviour of steel frames background knowledge of more precise analysis and safer design of steel frames against gravity and wind as well as key discussions on seismic analysis theoretical treatments followed by numerous examples and applications a review of the evolution of structural design approaches and reliability based advanced analysis followed by the methods and procedures for how to establish practical design formula

Advanced Design and Analysis of Steel Frames provides students researchers and engineers with an integrated examination of this core civil and structural engineering topic The logical treatment of both advanced analysis followed by advanced design makes this an invaluable reference tool comprising of reviews methods procedures examples and applications of steel frames in one complete volume

Plastic Design and Second-Order Analysis of Steel Frames Wai Fah Chen, I. Sohal, 1994-12-16 Plastic Design of Steel Frames assesses the current status and future direction of computer based analyses of inelastic strength and stability for direct frame design It shows how design rules are used in practical frame design and provides an introduction to the second order theory of inelastic frame design The book includes two computer programs on a diskette one for the first order analyses and the other for the second order plastic hinge analysis of planar frame design The second order program

can be used to predict realistic strengths and stabilities of planar frames thereby eliminating the tedious task of estimating factors for individual member capacity checks Both programs include clear input instructions The diskette also contains the Fortran source code listing for the second order plastic hinge analysis enabling the user to customize the program The programs will run on an IBM PC AT or equivalent machine with 640 kB of memory and 30 MB hard drive

Non-Linear Static and Cyclic Analysis of Steel Frames with Semi-Rigid Connections Siu-Lai Chan,Pui-Tak Chui,2000-05-19 This book is devoted to the discussion and studies of simple and efficient numerical procedures for large deflection and elasto plastic analysis of steel frames under static and dynamic loading In chapter 1 the basic fundamental behaviour and philosophy for design of structural steel is discussed emphasising different modes of buckling and the inter relationship between different types of analysis In addition to this different levels of refinement for non linear analysis are described An introduction is also given to the well known P and P effects Chapter 2 presents the basic matrix method of analysis and gives several examples of linear analysis of semi rigid pointed frames It is evident from this that one must have a good understanding of first order linear analysis before handling a second order non linear analysis In chapter 3 the linearized bifurcation and second order large deflection are compared and the detailed procedure for a second order analysis based on the Newton Raphson scheme is described Chapter 4 introduces various solution schemes for tracing of post buckling equilibrium paths and the Minimum Residual Displacement control method with arc length load step control is employed for the post buckling analysis of two and three dimensional structures Chapter 5 addresses the non linear behaviour and modelling of semi rigid connections while several numerical functions for description of moment versus rotation curves of typical connection types are introduced The scope of the work in chapter 6 covers semi rigid connections and material yielding to the static analysis of steel frames Chapter 7 studies the cyclic response of steel frames with semi rigid joints and elastic material characteristics In the last chapter the combined effects of semi rigid connections and plastic hinges on steel frames under time dependent loads are studied using a simple springs in series model For computational effectiveness and efficiency the concentrated plastic hinge concept is used throughout these studies

Stability Design of Steel Frames W.F. Chen,E.M. Lui,1991-07-24 Stability Design of Steel Frames provides a summary of the behavior analysis and design of structural steel members and frames with flexibly jointed connections The book presents the theory and design of structural stability and includes extensions of computer based analyses for individual members in space with imperfections It also shows how connection flexibility influences the behavior and design of steel frames and how designers must consider this in a limit state analysis and design procedure The clearly written text and extensive bibliography make this a practical book for advanced students researchers and professionals in civil and structural engineering as well as a useful supplement to traditional books on the theory and design of structural stability

Plastic Hinge Based Methods for Advanced Analysis and Design of Steel Frames Donald W. White,Wai-Fah Chen,Structural Stability Research Council,1993 Stability Design of

Steel Frames Wai-Kai Chen, 2017-11-29 Stability Design of Steel Frames provides a summary of the behavior analysis and design of structural steel members and frames with flexibly jointed connections The book presents the theory and design of structural stability and includes extensions of computer based analyses for individual members in space with imperfections It also shows how connection flexibility influences the behavior and design of steel frames and how designers must consider this in a limit state analysis and design procedure The clearly written text and extensive bibliography make this a practical book for advanced students researchers and professionals in civil and structural engineering as well as a useful supplement to traditional books on the theory and design of structural stability

Analysis of Steel Frames with Deformable Beam-to-column Connections Mario J. Scerbo, 1996

Advanced Analysis in Steel Frame Design Andrea Eden Surovek, 2012 This report presents formal guidelines for the use of second order inelastic analysis in the design and assessment of steel framing systems

Advanced Analysis of Steel Frames Subject to Local and Daren John King, Queensland University of Technology. School of Civil Engineering, 1996

Distributed Plasticity Analysis of Steel Frame Structures Comprising Non-compact Sections Philip Avery, Mahadeva Mahendran, 1998

Stability Design of Steel Frames Chen,

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Table of Contents Pushover Analysis Of Steel Frames Welcome To Ethesis

1. Understanding the eBook Pushover Analysis Of Steel Frames Welcome To Ethesis
 - The Rise of Digital Reading Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Advantages of eBooks Over Traditional Books
2. Identifying Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Pushover Analysis Of Steel Frames Welcome To Ethesis
 - User-Friendly Interface
4. Exploring eBook Recommendations from Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Personalized Recommendations
 - Pushover Analysis Of Steel Frames Welcome To Ethesis User Reviews and Ratings
 - Pushover Analysis Of Steel Frames Welcome To Ethesis and Bestseller Lists
5. Accessing Pushover Analysis Of Steel Frames Welcome To Ethesis Free and Paid eBooks
 - Pushover Analysis Of Steel Frames Welcome To Ethesis Public Domain eBooks
 - Pushover Analysis Of Steel Frames Welcome To Ethesis eBook Subscription Services
 - Pushover Analysis Of Steel Frames Welcome To Ethesis Budget-Friendly Options
6. Navigating Pushover Analysis Of Steel Frames Welcome To Ethesis eBook Formats
 - ePub, PDF, MOBI, and More
 - Pushover Analysis Of Steel Frames Welcome To Ethesis Compatibility with Devices
 - Pushover Analysis Of Steel Frames Welcome To Ethesis Enhanced eBook Features
7. Enhancing Your Reading Experience

- Adjustable Fonts and Text Sizes of Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Highlighting and Note-Taking Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Interactive Elements Pushover Analysis Of Steel Frames Welcome To Ethesis
8. Staying Engaged with Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Pushover Analysis Of Steel Frames Welcome To Ethesis
 9. Balancing eBooks and Physical Books Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Pushover Analysis Of Steel Frames Welcome To Ethesis
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Setting Reading Goals Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Fact-Checking eBook Content of Pushover Analysis Of Steel Frames Welcome To Ethesis
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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