

The Most Common Errors in Seismic Design ...And How to Properly Avoid Them

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Abstract

The paper identifies the most common errors that structural engineers make when performing seismic design and calculations. The paper demonstrates the proper application of Codes and Standards so as to avoid errors and misapplications. The paper initially focuses on low seismic risk design categories (and the surprisingly numerous seismic provisions which apply therein) and then advances to the requirements unique to high seismic risk design categories only.

Introduction

This paper is based upon IBC 2012, ASCE 7-10, AISC 360-10, ASCE 310-10, ACI 318-11 (including Chapter 21 and Appendix D) and other Standards. A few of the topics/common errors that are addressed include: Amplified seismic force Omega o, Cd deflection amplification, Modal analysis triggers, Rho redundancy factor, 0.7 E for Allowable Stress Design, Ev Vertical seismic effect, Vertical distribution of base shear, Orthogonal effects on corner columns, Diaphragm forces, Accidental torsion, Foundation ties, Unique calculations and detailing for Special Steel Systems, Concrete detailing and splice lengths when subject to high seismic, Wood frame hold-downs, Masonry wall anchors, and Wind governed buildings.

Seismic Design and Errors

This paper is written in checklist format. It is intended that an engineer could read the list so as to review and verify adequate knowledge of seismic design and common errors, as well as on a per project basis when checking a project by the engineer or by others. The basis of this paper is ASCE 7-10, and IBC 2012. Referenced sections are highlighted in brackets thus: [ASCE 7 Section Number].

1. Seismic Design Category A

[11.4.1] [11.7] [1.4]

[1.4 General Structural Integrity]

When in Seismic Design Category A, you should not use any of the provisions of Chapter 12. Instead, use the General Structural Integrity provisions of Section 1.4. Note that the General Structural Integrity provisions have some loads which may often be erroneously unaccounted for. The forces required include 15% dead load, 5% of dead plus live load for beam connections, and 20% of wall weight for wall connections. Non-Structural Components in Seismic Design Category A are exempt from Seismic Design requirements, as stated in Section 11.7.

2. Importance Factor

[11.5.1] [Table 1.5-2] [Table 1.5-1] [IBC Table 1604.5]

The Importance factor is based upon Risk Category and the associated Life Safety, Hazard and Essential nature of the structure. Both the ASCE 7 and IBC tables should be reviewed. A typical building can sometimes evolve into an I_p equal to 1.25 or 1.5 when occupancy or use expands. Examples include relatively small churches (occupancy greater than 300), or a building where hazardous materials are stored. It should be noted that for building design I_p = 1.0, 1.25, or 1.5 but for non-structural components I_p = 1.0, or 1.5 only [13.1.3] such that I_p may not equal I_e, and in some instances I_p may be less than I_e.

3. Continuous Load Path

[12.1.3] ASCE 7 has very specific provisions for many elements such collectors, connections, diaphragms, walls, etc. However, in addition to the specifics, the engineer is required by Section 12.1.3 to provide a continuous load path for all inertial forces from their origin to the foundation. Such load path shall conform to the relative stiffness and strength of the elements which exist in the structure.

4. R-Factor

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Seismic Design and Retrofit of Bridges M. J. N. Priestley, F. Seible, Gian Michele Calvi, 1996-04-12 Because of their structural simplicity bridges tend to be particularly vulnerable to damage and even collapse when subjected to earthquakes or other forms of seismic activity Recent earthquakes such as the ones in Kobe Japan and Oakland California have led to a heightened awareness of seismic risk and have revolutionized bridge design and retrofit philosophies In *Seismic Design and Retrofit of Bridges* three of the world's top authorities on the subject have collaborated to produce the most exhaustive reference on seismic bridge design currently available Following a detailed examination of the seismic effects of actual earthquakes on local area bridges the authors demonstrate design strategies that will make these and similar structures optimally resistant to the damaging effects of future seismic disturbances Relying heavily on worldwide research associated with recent quakes *Seismic Design and Retrofit of Bridges* begins with an in-depth treatment of seismic design philosophy as it applies to bridges The authors then describe the various geotechnical considerations specific to bridge design such as soil structure interaction and traveling wave effects Subsequent chapters cover conceptual and actual design of various bridge superstructures and modeling and analysis of these structures As the basis for their design strategies the authors focus is on the widely accepted capacity design approach in which particularly vulnerable locations of potentially inelastic flexural deformation are identified and strengthened to accommodate a greater degree of stress The text illustrates how accurate application of the capacity design philosophy to the design of new bridges results in structures that can be expected to survive most earthquakes with only minor repairable damage Because the majority of today's bridges were built before the capacity design approach was understood the authors also devote several chapters to the seismic assessment of existing bridges with the aim of designing and implementing retrofit measures to protect them against the damaging effects of future earthquakes These retrofitting techniques though not considered appropriate in the design of new bridges are given considerable emphasis since they currently offer the best solution for the preservation of these vital and often historically valued thoroughfares Practical and applications oriented *Seismic Design and Retrofit of Bridges* is enhanced with over 300 photos and line drawings to illustrate key concepts and detailed design procedures As the only text currently available on the vital topic of seismic bridge design it provides an indispensable reference for civil structural and geotechnical engineers as well as students in related engineering courses A state-of-the-art text on earthquake proof design and retrofit of bridges *Seismic Design and Retrofit of Bridges* fills the urgent need for a comprehensive and up-to-date text on seismic ally resistant bridge design The authors all recognized leaders in the field systematically cover all aspects of bridge design related to seismic resistance for both new and existing bridges A complete overview of current design philosophy for bridges with related seismic and geotechnical considerations Coverage of conceptual design constraints and their relationship to current design alternatives Modeling and analysis of bridge structures An exhaustive look at common building materials and

their response to seismic activity A hands on approach to the capacity design process Use of isolation and dissipation devices in bridge design Important coverage of seismic assessment and retrofit design of existing bridges

Applied Mechanics Reviews ,1976

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Engineering News-record ,1930

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courses It also can serve as a reference book for practicing engineers As the title implies it is heavily design oriented and discusses methods of applying engineering theories principles and research to practical design problems *Historical Building Construction: Design, Materials, and Technology (Second Edition)* Donald Friedman,2010 Winner of the Association for Preservation Technology APT 2012 Lee Nelson Book Award this book is an updated edition of the classic text detailing the ins and outs of old building construction A comprehensive guide to the physical construction of buildings from the 1840s to the present this study covers the history of concrete steel and skeleton frame buildings provides case histories that apply the information to a wide range of actual projects and supplies technical data essential to professionals who work with historic structures

Advances in Frontier Research on Engineering Structures Volume 2 Yang Yang,Sudharshan N. Raman,Bingxiang Yuan,Zhijun Xu,2023-02-08 *Advances in Frontier Research on Engineering Structures* focuses on the research of advanced structures and anti seismic design in civil engineering The proceedings present the most cutting edge research directions and achievements related to civil and structural engineering Topics covered in the proceedings include Engineering Structure and Seismic Resistance Structural Mechanics Analysis Components and Materials Structural Seismic Design 3D Printing Concrete Other Related Topics The works of this proceedings will promote development of civil and structural engineering resource sharing flexibility and high efficiency Thereby promote scientific information interchange between scholars from the top universities research centers and high tech enterprises working all around the world **JPT.**

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Concrete International ,2004 Petroleum World ,1927 **Proceedings, Fourth U.S. National Conference on Earthquake Engineering** ,1990 **Proceedings of ATC-29 Seminar and Workshop on Seismic Design and Performance of Equipment and Nonstructural Elements in Buildings and Industrial Structures** ,1992 SPE Global Link ,2001 **Reliability and Optimization of Structural Systems** D.M. Frangopol,R.B. Corotis,R. Rackwitz,1997-02-27 This book contains 38 papers presented at the seventh Working Conference on Reliability and Optimization of Structural Systems held at Boulder Colorado USA on April 2 4 1996 The Working Conference was organized by the IFIP International Federation for Information Processing Working Group 7 5 of Technical Committee 7 and was the seventh in a series of similar conferences The objectives of the Working Group and hence this publication are to promote modern structural systems optimization and reliability theory to advance international co operation in the field of structural system optimization and reliability theory to stimulate research development and application of structural system optimization and reliability theory to further dissemination and exchange of information on reliability and optimization of structural systems and to encourage education in structural system organization and reliability theory Modern Steel Construction ,2008 Atomic Energy Law Reporter ... Commerce Clearing House,1955 **Proceedings of Seminar on Seismic Design, Performance, and Retrofit of Nonstructural Components in Critical Facilities** ,2003

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