seismic design using structural dynamics

based on 2012 IBC / 2015 IBC / ASCE 7-10

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SKGA

ICC INTERNATIONAL CODE COUNCIL®

Seismic Design Using Structural Dynamics
based on 2012 IBC, 2015 IBC, and ASCE/SEI 7-10

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PREFACE

This publication addresses the methods by which a designer may comply with the seismic design requirements of the 2012 *International Building Code* (IBC)/2015 IBC/ASCE 7-10: Equivalent Lateral Force Procedure (ASCE 7-10 Section 12.8), Modal Response Spectrum Analysis (ASCE 7-10 Section 12.9), or Seismic Response History Analysis (ASCE 7-10 Chapter 16). The procedures in ASCE 7-10 Section 12.9 and Chapter 16 are more complicated than the Equivalent Lateral Force Procedure, but are required to be used under certain conditions of irregularity, occupancy, and height. Over the years, many questions have been asked about code provisions concerning these procedures and this publication has been created to answer these questions and demystify the application of the code with respect to modal response spectrum analysis.

Although ASCE 7-10 (the 2012 and the 2015 IBC) formally recognizes modal response spectrum analysis as well as seismic response history analyses, the modal response spectrum analysis is more common in design office usage and is therefore the primary subject of this publication. The background and details are explained in the first half (Chapter 1) of this publication where a step-by-step analysis procedure is given, and a three-story, one-bay frame example is solved entirely manually to illustrate application of the procedure.

The second half (Chapter 2) of this publication is devoted exclusively to the detailed design of a 20-story reinforced concrete building that utilizes a dual system consisting of specially detailed shear walls and frames for earthquake resistance. Modal response spectrum analysis is used as the basis of design. Design utilizing the Equivalent Lateral Force Procedure is also illustrated because it is basically a prerequisite to design using the Modal Response Spectrum Analysis Procedure.

A key feature of this 20-story design example that would be of particular interest to users is the design of reinforced concrete shear walls by the procedure in the 2011 edition of ACI 318 *Building Code Requirements for Structural Concrete.*

ACI 318-14 is the reference standard for concrete design and construction in the 2015 IBC. However, it is still under development. A 45-day public comment period is expected to commence around May 15, 2014 and publications is not expected until late fall, 2014. SKGA plans to update Part 2 of this publication to ACI 318-14, once that standard gets finalized, and issue a second printing based on ACI 318-14. ACI Committee 318 undertook a major reorganization effort following the publication of ACI 318-11, which is now about to culminate in ACI 318-14.Thus the update to Chapter 2 of this publication will be more challenging than it would have been in the absence of the extensive reorganization. The resulting update, however, would be highly valuable because it will steer the reader through a large part of the reorganized ACI 318-14.

ACKNOWLEDGEMENTS

Parts of this publication are influenced by an earlier book (Ghosh, S.K., Domel, Jr., A.W., and Fanella, D.A., *Design of Concrete Buildings for Earthquake and Wind Forces,* Publication EB 113.02D) from the Portland Cement Association, an organization to which the senior author owes much gratitude. This publication started out as a version, modified for the 2000 IBC, of an earlier publication: *Seismic Design Using Structural Dynamics (1997 UBC),* published by the International Conference of Building Officials. Dr. Madhu Khuntia, formerly of S. K. Ghosh Associates Inc., contributed much to the 1997 UBC publication. Dr. Kihak Lee, Saravanan Panchacharam, and Dr. David Fanella, formerly of S. K. Ghosh Associates Inc. played key roles in the first IBC update.

The 2000 IBC edition of the publication was subsequently updated to conform to the provisions of 2006 IBC/2009 IBC/ASCE 7-05. Dr. Jaehong Kim and Dr. Pro Dasgupta of S. K. Ghosh Associates Inc. and Dr. Farhad Shad of Ramboll Engineering Consultants contributed greatly to that update.

The contributions of Dr. Ali Hajihashemi of S. K. Ghosh Associates Inc. in the development of this edition of the publication are much appreciated.

About S. K. Ghosh Associates Inc.

The company provides seismic and code-related consulting services to engineers, businesses, trade associations, code-writing bodies, and governmental agencies involved in the design and construction of buildings and other structures that are impacted by the provisions of building codes. The company serves as a technical resource on structural codes and standards for code development and enforcement agencies and personnel; design professionals; academics; and the material industries. Technical support is provided through publications, seminars, peer reviews, research projects, computer programs, code interpretations and comparisons, a website, and other means.

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