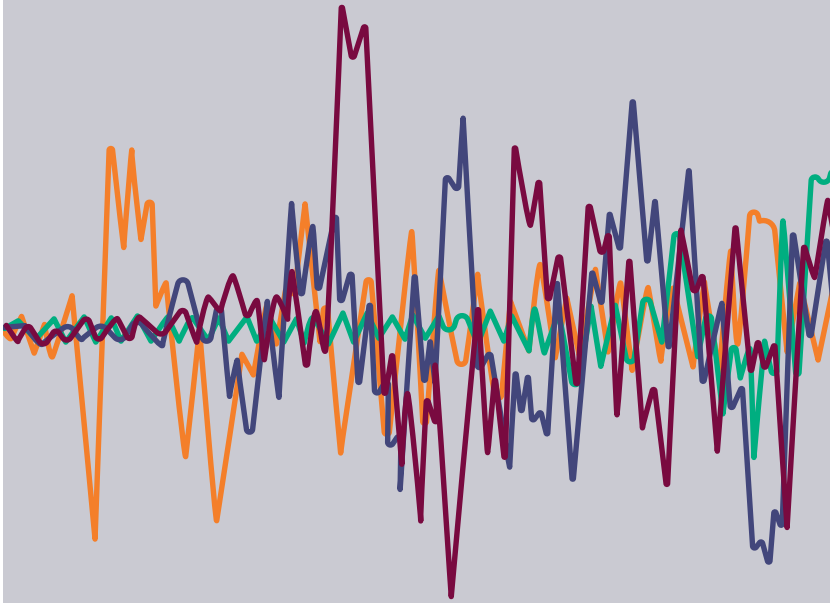
The Institution of StructuralEngineers

Examples for the seismic design of steel and concrete buildings to Eurocode 8

Examples to Eurocode: 8



IStructE Guide

The Institution of Structural Engineers

Examples for the seismic design of steel and concrete buildings to Eurocode 8

A companion to:

Manual for the seismic design of steel and concrete buildings to Eurocode 8

Authors

C Georgopoulos CEng FHEA FCS FICE FIStructE (Kingston University)
K H Kong BEng PhD CEng IntPE(UK) MIStructE (National University of Singapore)

Reviewers

N Ely BSc(Hons) CEng MIStructE MCIOB (The Environment Agency)
M Fox PhD CPEng IntPE(NZ) CMEngNZ (University of Pavia)
G W M Ho BEng(Hons) PhD CEng MIStructE (Arup)
J N Horsfield BEng MSc MIStructE (Beca)
T K N Lam BSc(Eng) MSc PhD CEng DIC MICE FIStructE MHKIE MIEAust (University of Melbourne)

Publishing

L Baldwin BA(Hons) DipPub (The Institution of Structural Engineers)

Front cover image: based on Seismosoft's SeismoMatch 2021 – A computer program for spectrum matching of earthquake records https://seismosoft.com/

Published by The Institution of Structural Engineers
International HQ
47–58 Bastwick Street
London EC1V 3PS
T: +44(0)20 7235 4535
E: mail@istructe.org
W: www.istructe.org

Published (version 1.0) February 2022

ISBN 978-1-906335-54-0 (print)
ISBN 978-1-906335-55-7 (pdf)

Contents

Acknowledgements

Permission to reproduce extracts from British Standards is granted by BSI. British Standards can be obtained in PDF or hard copy formats from the BSI online shop: www.bsigroup.com/Shop

Permission to reproduce the following has been obtained, courtesy of these individuals/organisations:

Figures 1.1–1.4 and 1.6: *Essential Knowledge Text No. 17: Dynamics* © Martin Williams
Figure 1.9: University of Ljubljana, Faculty of Civil and Geodetic Engineering: European Steel Design Education Programme. ESDEP WG17 – Seismic Design. Lecture 17.4: Structural Analysis for Seismic Actions. http://fgg-web.fgg.uni-lj.si/~/pmoze/esdep/master/wg17/l0400.htm
Figures 2.1 and 3.1: From: *Seismic Design of Buildings to Eurocode 8*, Ahmed Y Elghazouli (Ed.), Copyright © 2017 CRC Press. Reproduced by permission of Taylor & Francis Group
Figures 2.2, 2.3, 3.2–3.5 and 4.3: MPA The Concrete Centre
Figures 2.5, 3.6, 4.1, 4.2, 4.5, 7.1, 7.5 and 8.1: BSI
Figures 5.1 (plan), 5.2, 6.1 (plan), 7.6, 7.7, 8.4 and 8.6–8.8: Published in *Design of Steel Structures for Buildings in Seismic Areas: Eurocode 8: Design of structures for earthquake resistance. Part 1 – General rules, seismic actions and rules for buildings* by Raffaele Landolfo, Federico Mazzolani, Dan Dubina, Luís Simões da Silva and Mario D'Aniello Copyright © 2017 ECCS – European Convention for Constructional Steelwork. Published by John Wiley & Sons, Inc.
Figures 7.3 and 7.4: Copyright © American Institute of Steel Construction. Reprinted with permission. All rights reserved.

Tables 2.1, 3.1 and 4.1: YourSpreadsheets™
Tables 2.2, 3.2 and 4.2: MPA The Concrete Centre
Table 2.3 5.1, 5.2, 6.1 and 7.1: BSI

Tables

Figures

Foreword

This guidance is applicable to the design of buildings in earthquake-prone countries around the world, provided that any local requirements contained in the relevant National Annex or National Code of Practice are respected. Although the UK is classified as an area of very low seismicity for which design to BS EN 1998 (Eurocode 8)[1] is not a requirement, explicit consideration of seismic actions for the design of buildings in the UK may be required in certain circumstances.

The examples provided, complement The Institution of Structural Engineers' *Manual for the seismic design of steel and concrete buildings to Eurocode 8*[2], that assists the engineer engaged in the seismic design of structures to BS EN 1998. Readers are strongly advised to refer to the IStructE *Manual* when using this guidance. The terminology and notation used in the *Manual* is also used here.

The authors wish to thank Nelson Lam, Goman Ho, Neil Horsfield, Matt Fox and Nick Ely who contributed to the technical review process for this guidance.

Professor Costas Georgopoulos
School of Engineering and the Environment
Faculty of Science Engineering & Computing
Kingston University London

(Author of Examples 1–4)

Dr Kong Kian Hau
Department of Civil & Environmental Engineering
Faculty of Engineering
National University of Singapore

(Author of Examples 5–8)

Aims and scope

These examples provide simple calculations for the design of basic structural elements in reinforced concrete and steel for most buildings within the scope of BS EN 1998[1]. They are primarily intended for application in areas of moderate to high seismicity for the majority of low to medium-rise (not exceeding 40m), medium ductility class buildings. Readers may not have prior knowledge of BS EN 1998-1[3] but should have some prior experience of structural design to Eurocodes.

The first example introduces basic dynamics — as many engineers in non seismic-prone areas have not carried out the dynamic analysis of a building in the course of their studies/practice.

Examples 2–4 present the design of a beam, column and shear wall, in reinforced concrete respectively, while Examples 5–8 present the design of a beam, column, connection, and bracings, in steel respectively.

The examples have been designed to be used independently. As a result, a degree of repetition between each is unavoidable. Wherever possible, relevant imagery and tabulated information from third party sources have been included within the examples to aid readability.

Examples for the design of foundations and supporting soils are not provided; and suitably qualified, geotechnical engineers should be consulted in these instances. Examples of structural analysis, stability and robustness are covered extensively elsewhere and also not included here.

Note: analysis stress resultants used in the calculations in this guidance are arbitrary or taken from the analysis of arbitrary structures e.g. stress resultants in Examples 2, 3 and 4 are not related to each other, nor to the frame in Example 1.

It has also been observed that the capacity design principles in BS EN 1998-1 are not always applied appropriately in modern computer software or via hand calculations. These examples offer design calculations that follow the capacity design principles in BS EN 1998-1 and support the user's understanding of the code. They may also be used to assist with the validation and verification of software, and for checking software output.