

3rd Edition

SEISMIC Design Guide for METAL BUILDING SYSTEMS

Based on the 2015 IBC[®], ASCE/SEI 7-10, and AISC 360-10/341-10
(With Notes on the 2018[®] IBC, ASCE/SEI 7-16, and AISC 360-16/341-16)



ISBN 978-1-60983-873-7

Copyright by
MBMA
1300 Sumner Ave.
Cleveland, OH 44115-2851

COPYRIGHT 2018

Published by the International Code Council®

ALL RIGHTS RESERVED. This publication is a copyrighted work owned by the Metal Building Manufacturers Association. Without advance written permission from the copyright owner, no part of this book may be reproduced, distributed, or transmitted in any form or by any means, including, without limitation, electronic, optical, or mechanical means (by way of example and not limitation, photocopying or recording by or in an information storage and retrieval system). For information on permission to copy material exceeding fair use, please contact MBMA at 1300 Sumner Ave., Cleveland, OH 44115-2851. Phone: (216) 241-7333.

The information contained in this document is believed to be accurate; however, it is being provided for informational purposes only and is intended for use only as a guide. Publication of this document by the International Code Council should not be construed as the ICC or MBMA engaging in or rendering engineering, legal, or other professional services. Use of the information contained in this workbook should not be considered by the user as a substitute for the advice of a registered professional engineer, attorney, or other professional. If such advice is required, you should seek the services of a registered professional engineer, licensed attorney, or other professional.

Cover photographs provided by MBMA.

Publication date: January, 2019

First printing

Printed in the United States of America

TABLE OF CONTENTS

INTRODUCTION

I. BACKGROUND..... 1

 A. Purpose..... 1

 B. Style and Organization 1

 C. MBMA Seismic Guide Steering Committee..... 2

 D. Authors 3

II. TECHNICAL BASIS 3

 A. Codes and Standards Used as the Design Guide Basis..... 3

 B. Basic Concept of Seismic Code Reduced Forces 4

 C. Metal Building Standard Design and Analysis Practice/Economy 5

 D. Approach to Metal Building Roof Diaphragm Rigidity (Flexible vs. Rigid) and Accidental Torsion 6

 E. Lower Seismic Area Design Alternative..... 9

 F. Stability Analysis and Design 10

III. OTHER SIGNIFICANT ISSUES 10

 A. Advantages in Performing a Geotechnical Investigation 10

 B. Relationship Between the Metal Building Supplier and the Project Engineer of Record 11

 C. Relationship Between the Metal Building Supplier and Foundation/Hardwall Engineer..... 12

 D. Hardwall Detailing and Actual Behavior..... 13

 E. Low Occupancy Industrial Structures and Nonbuilding Structures 14

DESIGN EXAMPLE 1

Determination of Seismic Design Forces

Problem Statement..... 1-2

Design Example Objective..... 1-2

1. DETERMINE EARTHQUAKE DESIGN FORCES 1-3

 1.1. Compute Site Ground Motion Design Values 1-3

 1.2. Determine the Risk Category, Importance Factor, and Seismic Design Category for each Site/Building 1-6

 1.3. Determine the Seismic Base Shear, V , for each Building 1-7

 1.4. Determine Seismic Load Effects, E and E_m , for each Building in each Direction..... 1-24

DESIGN EXAMPLE 2

Design of Frames, Columns, Bracing and Other Elements of the Lateral-Force-Resisting System

| | |
|---|------|
| Problem Statement..... | 2-3 |
| Design Example Objectives..... | 2-3 |
| 2. DESIGN OF TYPICAL MEMBERS AND CONNECTIONS..... | 2-4 |
| 2.1. General Design Guidance | 2-4 |
| 2.2. Design Building A..... | 2-11 |
| 2.3. Design Building B..... | 2-49 |
| 2.4. Beam-to-Column Connection Design..... | 2-80 |
| 2.5. Column Base and Anchor Bolt Design..... | 2-89 |
| 2.6. Foundation Forces for Foundation Design..... | 2-90 |
| 2.7. Welding Issues and Quality Assurance Requirements..... | 2-96 |
| 2.8. Approved Steel and Welding Material..... | 2-98 |

DESIGN EXAMPLE 3

Evaluation of Design Options for a Metal Building System with a Concrete Deck Mezzanine (Rigid Diaphragm)

| | |
|---|------|
| 3. BACKGROUND..... | 3-2 |
| 3.1. Case 1 – Small Interior Mezzanine | 3-7 |
| 3.2. Case 2 – Small Mezzanine Full Length of Building | 3-11 |
| 3.3. Case 3 – Large Mezzanine as Separate Story | 3-15 |
| 3.4. Case 4 – Partial Mezzanine Along Sidewall | 3-21 |

DESIGN EXAMPLE 4

Determination of Seismic Design Forces and Detailing Requirements for a Metal Building with Concrete or Masonry Walls (Hardwalls)

| | |
|---|------|
| Problem Statement..... | 4-2 |
| Design Example Objective..... | 4-2 |
| 4. DISTRIBUTION OF SEISMIC DESIGN LOADS..... | 4-3 |
| 4.1. Determine Earthquake Design Forces..... | 4-3 |
| 4.2. Wall Design and Wall to Metal Connection | 4-14 |
| 4.3. Side Wall Girts | 4-26 |

APPENDIX

A-1 Multi-Tiered Braced Frames..... A-2
A-2 Seismic Force Resisting Systems with Cold-Formed and Hot Rolled Steel..... A-3
A-3 Period Calculation A-4
A-4 Research on Metal Building Moment Frames..... A-6
A-5 Hardwall Connection Design A-12
A-6 Rigid-Wall, Flexible-Diaphragm Buildings A-17
A-7 Crane Buildings..... A-18
A-8 References..... A-19