

**ACI 352.1R-11**

# **Guide for Design of Slab-Column Connections in Monolithic Concrete Structures**

Reported by Joint ACI-ASCE Committee 352



**American Concrete Institute®**

This is a preview. [Click here to purchase the full publication.](#)

## **Guide for Design of Slab-Column Connections in Monolithic Concrete Structures**

Copyright by the American Concrete Institute, Farmington Hills, MI. All rights reserved. This material may not be reproduced or copied, in whole or part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of ACI.

The technical committees responsible for ACI committee reports and standards strive to avoid ambiguities, omissions, and errors in these documents. In spite of these efforts, the users of ACI documents occasionally find information or requirements that may be subject to more than one interpretation or may be incomplete or incorrect. Users who have suggestions for the improvement of ACI documents are requested to contact ACI via the errata website at [www.concrete.org/committees/errata.asp](http://www.concrete.org/committees/errata.asp). Proper use of this document includes periodically checking for errata for the most up-to-date revisions.

ACI committee documents are intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. Individuals who use this publication in any way assume all risk and accept total responsibility for the application and use of this information.

All information in this publication is provided “as is” without warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose or non-infringement.

ACI and its members disclaim liability for damages of any kind, including any special, indirect, incidental, or consequential damages, including without limitation, lost revenues or lost profits, which may result from the use of this publication.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

Participation by governmental representatives in the work of the American Concrete Institute and in the development of Institute standards does not constitute governmental endorsement of ACI or the standards that it develops.

Order information: ACI documents are available in print, by download, on CD-ROM, through electronic subscription, or reprint and may be obtained by contacting ACI.

Most ACI standards and committee reports are gathered together in the annually revised ACI Manual of Concrete Practice (MCP).

**American Concrete Institute**  
**38800 Country Club Drive**  
**Farmington Hills, MI 48331**  
**U.S.A.**  
**Phone: 248-848-3700**  
**Fax: 248-848-3701**

**[www.concrete.org](http://www.concrete.org)**

ISBN 978-0-87031-760-6

[This is a preview. Click here to purchase the full publication.](#)

## Guide for Design of Slab-Column Connections in Monolithic Concrete Structures

Reported by Joint ACI-ASCE Committee 352

Mary Beth D. Hueste<sup>†</sup>  
Chair

Thomas Kang<sup>†</sup>  
Secretary

Sergio M. Alcocer  
John F. Bonacci  
James R. Cagley  
Marvin E. Criswell  
Jeffrey J. Dragovich  
Catherine E. French  
Luis E. García  
Russell Gentry  
Theodor Krauthammer  
Michael E. Kreger  
James M. LaFave\*  
Douglas D. Lee  
Dawn E. Lehman  
Roberto T. Leon  
Cheng-Ming Lin  
Donald F. Meinheit  
Nilanjan Mitra  
Jack P. Moehle  
Stavroula J. Pantazopoulou  
Gustavo J. Parra-Montesinos

Ian Robertson<sup>†</sup>  
M. Saiid Saiidi  
Jorge I. Segura  
Bahram M. Shahrooz  
Myoungsu Shin  
John W. Wallace  
James K. Wight  
Loring A. Wyllie Jr.

*Consulting Members*  
Hossam M. Abdou  
Fariborz Barzegar  
Hugh L. Cotton  
Filip C. Filippou  
David W. Mitchell  
Charles F. Scribner  
David Z. Yankelevsky  
Liande Zhang

\*Chair of editorial subcommittee

<sup>†</sup>Member of editorial subcommittee

*This guide provides recommendations for determining proportions and details of monolithic reinforced and post-tensioned concrete slab-column connections.*

*Included are recommendations regarding appropriate uses of slab-column connections in structures resisting gravity and lateral forces; procedures for determination of connection load-carrying capacity; and reinforcement details to achieve adequate strength, ductility, and structural integrity. Recommendations are based*

*on a review of the literature for ultimate and serviceability limit states. A commentary is provided to clarify the recommendations and identify reference material. Design recommendations are set in standard type. Commentary is set in italics.*

**Keywords:** connection; flat plate; flat slab; joint; lateral drift; post-tensioned; punching shear; seismic; shear reinforcement; slab-column.

### CONTENTS

#### Chapter 1—Introduction and scope, p. 2

##### 1.1—Introduction

##### 1.2—Scope

ACI Committee Reports, Guides, and Commentaries are intended for guidance in planning, designing, executing, and inspecting construction. This document is intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. The American Concrete Institute disclaims any and all responsibility for the stated principles. The Institute shall not be liable for any loss or damage arising therefrom.

Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/Engineer to be a part of the contract documents, they shall be restated in mandatory language for incorporation by the Architect/Engineer.

ACI 352.1R-11 supersedes ACI 352.1R-89 and was adopted and published March 2012.

Copyright © 2011, American Concrete Institute.

All rights reserved including rights of reproduction and use in any form or by any means, including the making of copies by any photo process, or by electronic or mechanical device, printed, written, or oral, or recording for sound or visual reproduction or for use in any knowledge or retrieval system or device, unless permission is granted in writing by the American Concrete Institute.

This is a preview. Click here to purchase the full publication.

**Chapter 2—Notation and definitions, p. 3**

- 2.1—Notation
- 2.2—Definitions

**Chapter 3—Connection classifications, p. 4**

- 3.1—General
- 3.2—Connection classifications

**Chapter 4—Design considerations, p. 8**

- 4.1—Connection performance
- 4.2—Types of actions on the connection
- 4.3—Determination of connection forces

**Chapter 5—Methods of analysis for determination of connection strength, p. 9**

- 5.1—General principles and recommendations
- 5.2—Connections without beams
- 5.3—Connections with transverse beams
- 5.4—Effect of openings
- 5.5—Joint strength

**Chapter 6—Reinforcement, p. 13**

- 6.1—Slab reinforcement for moment transfer
- 6.2—Joint recommendations
- 6.3—Structural integrity reinforcement
- 6.4—Anchorage of reinforcement

**Chapter 7—Lateral drift, p. 20**

- 7.1—General
- 7.2—Lateral drift capacity

**Chapter 8—Shear reinforcement, including for earthquake-resistant design, p. 22**

- 8.1—General
- 8.2—Types of shear reinforcement
- 8.3—Shear strength of connections with shear reinforcement

**Chapter 9—References, p. 25**

- 9.1—Referenced standards and reports
- 9.2—Cited references

**CHAPTER 1—INTRODUCTION AND SCOPE****1.1—Introduction**

The recommendations in this guide are for determining connection proportions and details to provide adequate performance of cast-in-place reinforced concrete (RC) and post-tensioned concrete (PT) slab-column connections. The recommendations are written to satisfy serviceability, strength, and ductility requirements related to the intended functions of the connection.

*Design of the connection between a slab and its supporting member requires consideration of both the joint and the portion of the slab, or slab and beams, immediately adjacent to the joint. Several connection failures associated with inadequate performance of the slab adjacent to the joint have been reported (Engineering News-Record (ENR) 1956,*

*1971, 1973; Joint ACI-ASCE Committee 426 1974; Leyendecker and Fattal 1977; Lew et al. 1982a,b; Rosenblueth and Meli 1986; Freyermuth 1989; Moehle 1996; Hueste and Wight 1997). However, no reported cases of connection failure due to distress within the joint have been identified. Some connection failures have occurred during construction when young concrete slabs received loads from more than one floor as a consequence of shoring and reshoring (Agarwal and Gardner 1974; Lew et al. 1982a,b; Sbarounis 1984; ACI 347-05). The disastrous consequences of some failures, including total collapse of the structure, emphasize the importance of the design of the connection. These recommendations are intended to alert the designer to those aspects of behavior that should be considered in design of the connection and to suggest design procedures that will lead to adequate connection performance.*

**1.2—Scope**

*Information and design recommendations have been summarized by Joint ACI-ASCE Committee 426 (1974, 1977). This guide is an update of ACI 352.1R-89 (Joint ACI-ASCE Committee 352 1989), based on research information presented in references such as Moehle (1996); Moehle et al. (1988); Kang and Wallace (2005); ACI 318-08, Chapter 21; and Cheng et al. (2010). Modifications to the previous report include expanding the coverage to include slab-column connections with shear reinforcement, slab-column connections with post-tensioning reinforcement, and lateral drift capacity of both RC and PT slab-column connections.*

These recommendations apply only to slab-column connections in monolithic concrete structures, with or without drop panels or column capitals, and using normal-weight or lightweight concrete. For strength calculation purposes, the specified concrete compressive strength should not be taken greater than 6000 psi (42 MPa). The recommendations are limited to slab-column connections with slab thickness ranging between 5 and 12 in. (125 and 300 mm); a slab span-to-thickness ratio varying from 20 to 45, except for slab-column connections with transverse beams; and a ratio of long-to-short cross-sectional column dimensions less than 4. The recommendations for PT slab-column connections are applicable only for monolithic concrete connections with unbonded post-tensioning tendons applying an average compressive stress in the concrete not less than 125 psi (0.86 MPa). Construction that combines slab-column and beam-column framing in orthogonal directions at individual connections is included, but these recommendations are limited to issues related to the transfer of loads in the direction perpendicular to the beam axis. Slab-column framing systems are considered inappropriate as seismic-force-resisting systems assigned to high seismic design categories, but they are commonly used as frames not designated as part of the seismic-force-resisting system along with a stiffer seismic-force-resisting system, such as shear walls or beam-and-column moment-resisting frames.

*These recommendations are limited to slab-column connections of cast-in-place RC and PT floor construction, including two-way ribbed floor slab construction (Meli and*