

ACI 551.1R-14

Guide to Tilt-Up Concrete Construction

Reported by ACI Committee 551



American Concrete Institute
Always advancing



Guide to Tilt-Up Concrete Construction

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 <http://concrete.org/Publications/DocumentErrata.aspx>. 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
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

Guide to Tilt-Up Concrete Construction

Reported by ACI Committee 551

Jeff Griffin, Chair

James R. Baty II, Secretary

Iyad M. Alsamsam
William R. Braswell
Jerry D. Coombs
Darryl E. Dixon
Michael Fulton
John G. Hart
Robert P. Hirsch

Brent E. Hungerford
Anthony I. Johnson
Philip S. Kopf
Kimberly Waggle Kramer
James S. Lai
John W. Lawson
Ed T. McGuire

Andrew S. McPherson
Trent C. Nagele
Craig J. Olson
Lance Osborne
Jayendra R. Patel
J. Edward Sauter
Nandu K. Shah

Joseph J. Steinbicker
Jason A. Swagert
Gerry J. Weiler

Consulting members
Hugh Brooks
David L. Kelly

Tilt-up concrete construction is commonly used in low- to mid-rise building construction. This guide reviews the many issues related to the planning and construction of tilt-up buildings to produce a quality tilt-up project. Major topics include preconstruction planning, foundations, special considerations for slab-on-ground construction, wall panel forming and casting, panel erection, connections and repairing, and painting. This guide also contains sections on sustainability and insulation systems, as well as references to the relevant codes and standards including updated Occupational Safety & Health Administration (OSHA) safety regulations.

Keywords: forming; finish; inserts; insulation; panel; precast; release agent; sandwich panel; site cast; sustainability; tilt-up.

CONTENTS

CHAPTER 1—INTRODUCTION AND SCOPE, p. 2

1.1—Introduction, p. 2

CHAPTER 2—DEFINITIONS, p. 2

CHAPTER 3—HISTORY, TRENDS, AND SUSTAINABILITY, p. 3

3.1—History of tilt-up construction, p. 3

3.2—Trends, p. 4

3.3—Sustainability, p. 4

CHAPTER 4—PRECONSTRUCTION PLANNING, p. 6

4.1—Introduction, p. 6

4.2—Site layout and crane access, p. 6

4.3—Review of drawings, p. 7

4.4—Production schedule, p. 7

4.5—Submittals, p. 7

4.6—Staging, p. 8

4.7—Crews, p. 8

4.8—Panel layout and erection, p. 8

4.9—Casting beds and stack casting, p. 8

4.10—Concrete placement and testing, p. 9

4.11—Panel orientation and bracing, p. 9

4.12—Safety planning, p. 10

CHAPTER 5—FOUNDATIONS, p. 11

5.1—Foundation systems, p. 11

5.2—Continuous footings, p. 11

5.3—Spread footings, p. 12

5.4—Foundation walls, p. 12

5.5—Deep foundations (piles and drilled piers), p. 12

5.6—Foundation elevation versus bottom of panel elevation, p. 13

5.7—Backfill at loading dock high panels, p. 14

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 551.1R-14 supersedes ACI 551.1R-05 and was adopted and published November 2014.

Copyright © 2014, 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 in writing is obtained from the copyright proprietors.

CHAPTER 6—CONSIDERATIONS FOR SLAB-ON-GROUND CONSTRUCTION, p. 14

- 6.1—Temporary construction loads, p. 14
- 6.2—Floor slab (casting bed) preparation, p. 14
- 6.3—Joints and openings, p. 15
- 6.4—Slab closure strips (pour strips), p. 16
- 6.5—Floor slab repair, p. 16

CHAPTER 7—WALL PANEL FORMING AND CASTING, p. 17

- 7.1—Forming, p. 17
- 7.2—Architectural treatments, p. 20
- 7.3—Reinforcement placement, p. 26
- 7.4—Steel embedment plates, p. 27
- 7.5—Lifting and bracing inserts, p. 27
- 7.6—Concrete placement, finishing, and curing, p. 29

CHAPTER 8—PANEL ERECTION, p. 31

- 8.1—Before erection, p. 31
- 8.2—Rigging, p. 31
- 8.3—Panel erection sequence, p. 31
- 8.4—Safety, p. 33

CHAPTER 9—CONNECTIONS, p. 33

- 9.1—Design of connections, p. 33
- 9.2—Foundation and slab-on-ground connections, p. 33
- 9.3—Roof connections and supported floor connections, p. 35
- 9.4—Panel-to-panel connections, p. 37
- 9.5—Connections for higher seismic design categories, p. 38

CHAPTER 10—FINISHING AND SEALING, p. 38

- 10.1—Surface preparation, p. 38
- 10.2—Repairs, p. 38
- 10.3—Joints, p. 39
- 10.4—Paints, p. 40

CHAPTER 11—INSULATED PANELS, p. 41

- 11.1—Insulated panels, p. 41
- 11.2—Sandwich panels, p. 41
- 11.3—Insulation, p. 42

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Tilt-up concrete construction is a unique form of site-cast precast construction where building elements commonly referred to as panels are constructed in job-site conditions and set in place within the building design. The conditions of casting location and positioning within the building design, therefore, necessitate tilt-up's own specialized set of design parameters and construction techniques. Tilt-up panels are generally handled only once. They are lifted or tilted from the casting slab and erected in their final position in one continuous operation.

ACI defines tilt-up as “a construction technique for casting concrete elements in a horizontal position at the job site and then tilting them to their final position in a structure.” ACI 318 further states that tilt-up concrete construction is a form of precast concrete. Several features make the tilt-up construction method unique.

Tilt-up panels serve as many functions for building design as markets in which they are constructed. Panels, or perhaps better described as tilt-up elements are constructed with and without openings, sometimes consisting of only a grid of monolithic beams and columns. Wall panels are found flat, ribbed, curved (with broad to tight radii), and even biaxially curved. Elements have been constructed freestanding and cantilevered, simply supported, and connected in a variety of configurations. Elements have been taller than 96 ft (30 m) (Lucky Street Parking Garage, Hollywood, FL) and building façades have been stacked as high as 138 ft (42 m) (ASU Student Housing, Phoenix, AZ). Not all tilt-up elements are building panels, however. Although the majority produced annually are designed as either load- or nonload-bearing building envelope panels, tilt-up elements have also been featured as signs, monuments and art, walkways, stadium seat supports, spires, tanks, tunnels, and bridges.

1.2—Scope

This guide presents the basic concepts, techniques, and procedures used in tilt-up construction. The design of tilt-up wall panels, although not addressed in this guide, is addressed in the companion design guide ACI 551.2R, which is beneficial in content to both licensed design professionals and contractors. This guide includes a brief history of tilt-up concrete and a discussion of planning; foundation and floor slab construction; and wall panel forming, casting, and erection. It briefly describes typical connections used to attach the panels to the rest of the structure, and options for panel finishes are briefly described.

CHAPTER 2—DEFINITIONS

ACI provides a comprehensive list of definitions through an online resource, “ACI Concrete Terminology,” <http://www.concrete.org/Tools/ConcreteTerminology.aspx>. Definitions provided herein complement that resource.

bolster strip—continuous reinforcement support device for wire mesh or mat in a concrete slab or wythe element.

cribbing—wood blocking set under crane outriggers to spread the point load over a larger area to prevent damage to the supporting surface.

densifier—chemical applied to a concrete surface to fill pores, increasing surface density.

elastomeric paint—paint consisting of a polymer with elasticity, generally having low Young's Modulus and high yield strain compared with other materials that behave as a rubber-like membrane on the concrete surface to span cracks and decrease permeability.

hygrothermal analysis—analysis of the movement of heat and moisture through buildings, particularly a building envelope, component, or system.

membrane bond breaker—nonchemically active release