Tilt-Up Construction

Individual Certification and Preparatory Seminar

Presented by the Tilt-Up Concrete Association
www.tilt-up.org

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This program has been approved for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement of any material of construction or any method or manner of handling, using or distributing or dealing in any material or product by the AIA/CES, MCAA or ACI/TCA.

Questions related to specific materials, methods and services will be addressed at the conclusion of this presentation.

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Tilt-Up Concrete Association

The mission of the Tilt-Up Concrete Association is to expand and improve the use of tilt-up as the preferred building system by providing education and resources that enhance quality and performance.

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Tilt-Up Concrete Association

Networking
Education
Technical Support
Resources
Standards
Certification
Recognition
Referrals

www.tilt-up.org/membership

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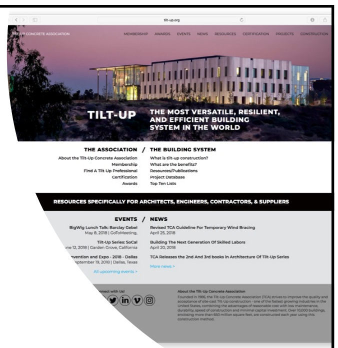
Tilt-Up Concrete Association

- Contractors
- Engineers
- Architects
- Suppliers

Search the TCA Member Directory, discover member benefits, events, resources and more at www.tilt-up.org.



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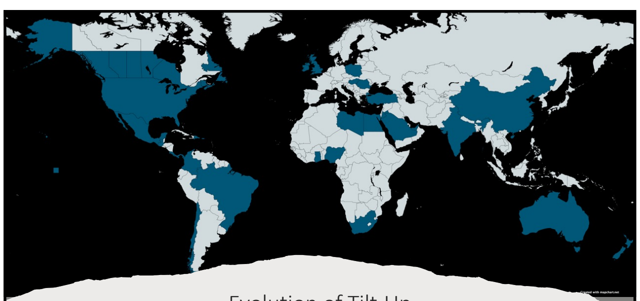

Evolution of Tilt-Up

Tilt-Up Market Growth Across the Globe

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Evolution of Tilt-Up

Big Boxes

Warehousing/Distribution

The Most Economical

- Single Story
- Few or No Windows
- Repetitive Structures & Panels

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Evolution of Tilt-Up

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Evolution of Tilt-Up

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Tilt-Up Today

- Multi-Story Buildings
- Tall and Large Panels
- Curved Panels
- Varied Finishes
- Complex Shapes
- **Virtually Every Building Type**

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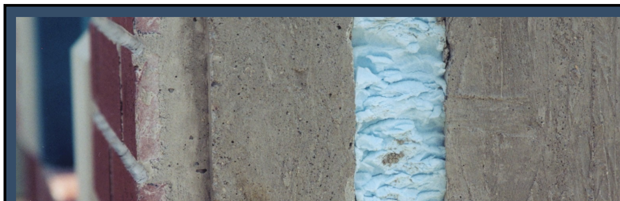

Thermal Performance

Commercial Building Envelope Requirements

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Insulation Systems

- **TCA Composite Panel Research**
  - Un-Interrupted Insulation
  - Multiple Systems
  - Unified Design Method
  - Presentation during 2021 Tilt-Up Convention
  - Report Early 2022

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Fire Resistance

International Building Code
Fire Performance of Solid Concrete Wall Systems

Concrete Type	1-hour	1.5-hour	2-hour	3-hour	4-hour
Siliceous	3.5	4.3	5.0	6.2	7.0
Carbonate	3.2	4.0	4.6	5.7	6.6
Sand-Lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

** - all values in inches*

- Special Joint Treatment for Fire Rated Wall Assembly
- No U.L Rating for Site Constructed Units

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Advantages of Tilt-Up

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Design for Progressive Collapse

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Advantages of Tilt-Up

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Advantages of Tilt-Up

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Engineering Tilt-Up

Introduction

- Engineering Tilt-Up / The Architecture of Tilt-Up / Construction of Tilt-Up
- 2012 International Building Code (2012 IBC) and its referenced material and load standards such as ACI 318-11 and ASCE/SEI 7-10
- Recommendations from ACI 551.2R-10, Design Guide for Tilt-Up Panels
- 7 chapters and 3 complete building examples
- Definition of "Tilt-Up" –

  ACI 318-11 defines precast concrete as "structural concrete element cast elsewhere than its final position in the structure." ACI 318-11 commentary section R16.1.1 expands the definition by stating, "Tilt-up concrete construction is a form of precast concrete."

  Other ACI documents, however, recognize that tilt-up has unique features that differentiate it from precast elements cast in a plant.

  The definition adhered to in this manual and supported by TCA is that tilt-up is simply a unique form of precast concrete construction.

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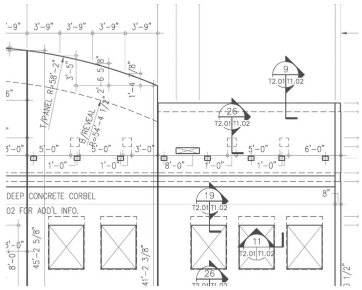
Drawings

- Building Drawing
  - Elevations
  - Foundation Plan
  - Roof Framing Plan
  - Wall Sections, Details
- Shop Drawings
- Panel Drawings



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Engineering Tilt-Up

Introduction

Overview of Tilt-Up:

- 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.
- Tilt-up panels are generally of such large size and weight that they can only be constructed on site and in close proximity to their final location in the structure.
- Panel gravity loads are supported directly by the foundation instead of being supported by a structural frame.
- Typically, tilt-up panels are erected before the structural frame.
- Tilt-up panels are usually load-bearing for gravity loads and resist lateral loads.

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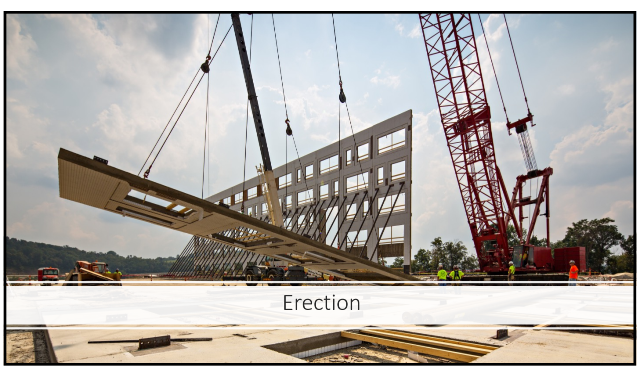

Erection

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Blind Picks
• Crane Operator Cannot See Lifting Connections After Initial Erection
• Rigging Crew Foreman Signals Crane Operator with Hand Signals
• Position In Sight of Crane Operator and Crew

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Walking Panels
• Monitor Space Between Crane and Panel
• No One in Path of Travel

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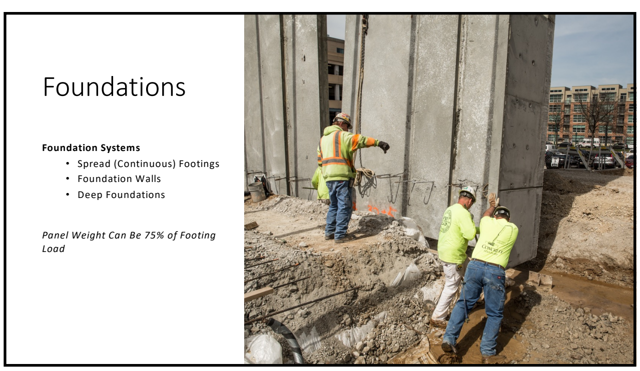
Foundations
Foundation Systems
• Spread (Continuous) Footings
• Foundation Walls
• Deep Foundations
Panel Weight Can Be 75% of Footing Load

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Foundations

- Footings Typically 1"-2" Below Bottom of Panel
- Adjust Height with Shim Packs

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Panel Cracking

- Causes of Cracks?
- When are They a Problem?

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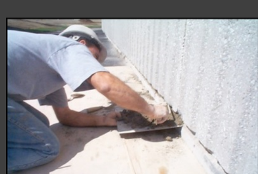
Grouting



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Walk-Out Panel

- Concern if Lifting from Slab
- Do Not Lift Twice from Horizontal
- Lift and Brace Temporarily

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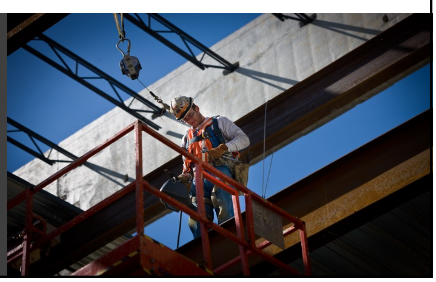
Structural Connections

Braces MUST Remain In-Place Until the Engineer of Record Confirms They Can Be Removed!



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Engineering Tilt-Up

Introduction

Typical Construction of Tilt-Up:

- The sizes and thicknesses of panels, location of joints, and the layout and anticipated performance of the lateral force resisting system must be identified early.
- The first item to be resolved is usually the layout of the roof framing (and floor framing if applicable).
  - Bay spacing is often determined as much by functional use requirements as by economics of framing systems
  - Typically, roof framing consists of 1½-in. steel deck spanning between steel joists
  - Joist spacing is generally about six feet, plus or minus, and based on a module of the bay size
  - The joists span between steel girders/joist girders and/or exterior walls
  - Bay sizes are generally 40 ft to 60 ft

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Tilt-Up
Structural
Concept

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Engineering Tilt-Up
Introduction

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Engineering Tilt-Up
Introduction

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Engineering Tilt-Up

Introduction

Practical Considerations for Tilt-Up:

- Preferable to keep the panels a uniform thickness on a given wall line rather than using pilasters that project from the face of the wall.
- Since wall panels are designed to span vertically between the slab-on-ground and roof (or intermediate floors), it is important to know the heights of the panels as soon as possible.
- Are additional interior tilt-up shear walls or other vertical lateral force resisting elements needed?
- Tilt-up panels are often designed for out-of-plane loading and checked or slightly modified as necessary to show adequacy as shear walls.
- Opening sizes, wall lengths, building height, and magnitude of seismic and wind demands can make in-plane shear design more challenging. Very large openings throughout a wall line may require that the tilt-up panels be designed and detailed as moment frames or as shear walls with pier and spandrel detailing in order to best satisfy the intent of the seismic provisions contained in ACI 318-11.

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Engineering Tilt-Up

Introduction

Practical Considerations for Tilt-Up (continued):

- For a preliminary estimate of panel size and thickness, a handy rule-of-thumb is that panels should not exceed about 40 to 50 tons. This will need to be verified for a specific project based on the local availability of a crane with adequate capacity.

  For illustration, a 25 ft wide by 35 ft tall panel, 7 ¼" thick, weighs about 40 tons. However, this is only a rule of thumb. This limit is often exceeded with the availability of higher capacity cranes, the need for taller panels to provide more interior clear height, and the need for multi-story panels.
- ACI 318-11 includes procedures for tilt-up panels (Section 14.8 – Alternate Design of Slender Walls)
- ACI 551.2R-18 provides design guidance to interpret ACI 318 provisions and provides multiple panel design examples

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Engineering Tilt-Up

Introduction

Panelizing the Tilt-Up Wall:

- Panelizing means determining how the wall elevations are divided into segments or panels.
- Determining the practical shapes of panels (from an erection and load bearing perspective) and widths (considering erection rigging and panel weight when determining maximum panel widths)
- Set the typical panel widths equal to a module of the project bay size and framing spacing with narrower panels at the corners.
- The architect generally controls the aesthetic layout of joints with direct input from the structural engineer on the structural implications. Unfortunately, the architect sometimes establishes the panel joint locations without these considerations only to learn later that they must be changed to alleviate structural or erection problems. Panel joints allow for expansion & contraction and are usually a ¾-inch wide caulked joint. Connection of the panels at the joints should be avoided unless required for panel stability due to overturning analysis.

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Alternate Fact: Panel Shape

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Curved Panels

Curved panels and forms are common. Both in the form of curved walls as well as curved edges or shapes.

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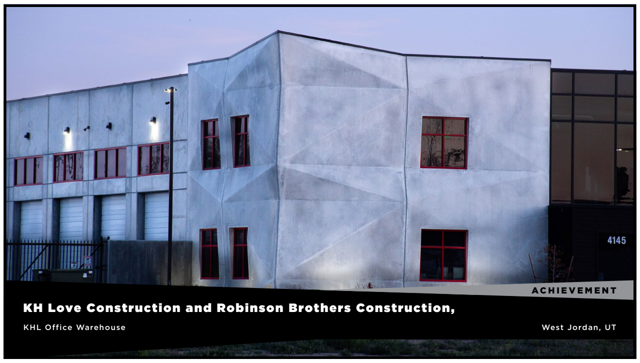
4145
ACHIEVEMENT
KH Love Construction and Robinson Brothers Construction,
KHL Office Warehouse
West Jordan, UT

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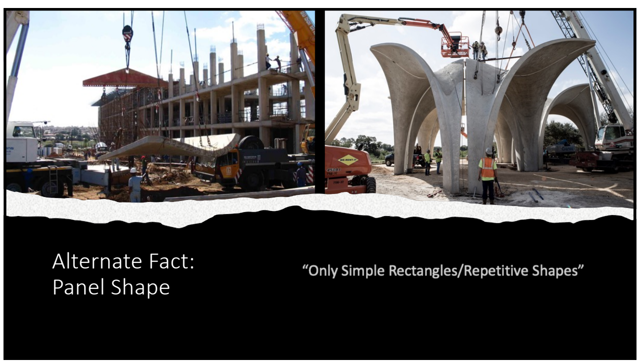
Alternate Fact:
Panel Shape
“Only Simple Rectangles/Repetitive Shapes”

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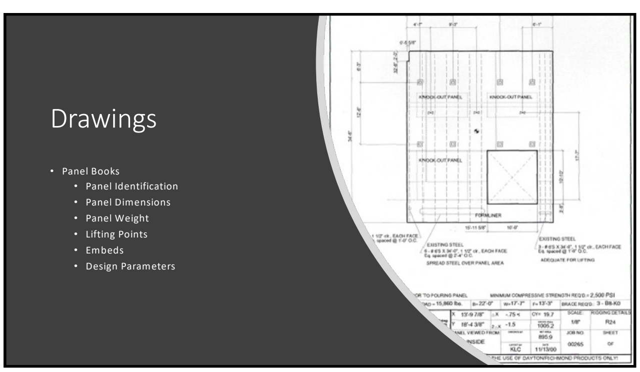
Drawings
• Panel Books
• Panel Identification
• Panel Dimensions
• Panel Weight
• Lifting Points
• Embeds
• Design Parameters

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Engineering Tilt-Up

Introduction

Panelizing the Tilt-Up Wall (continued):

- Typically, a minimum panel leg width may be in the range of 18-24 inches, but this will vary depending on the applied loads, panel thickness and adjacent opening size. It should be noted that although not architecturally possible in some cases, locating openings symmetrically in the panel is preferable from an erection standpoint.
- Panel sizes should be selected to minimize the number of panels required and maximize the erection efficiency of the crane and crew.
- For example, a 600 sf panel can be lifted and placed in nearly the same amount of time as a 200 sf panel.
- A good rule-of-thumb is that a hydraulic all terrain crane should have a capacity, in tons, of 2.5 to 3 times the maximum panel weight in kips. For example, if the maximum panel weight on the project is 50 kips, the ideal crane size would be a 125 to 150 ton crane.

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Selecting the Crane

- Crane Reach
- Lifting Platform
- Panel Size and Weight

Rule of thumb: 3 times heaviest panel weight

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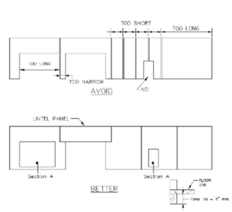
Panelization

Determine

- Shape
- Joint Location
- Weight (Crane)

Involve

- Contractor
- Engineer of Record
- Architect



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Engineering Tilt-Up

Introduction

Panelizing the Tilt-Up Wall (continued):

- The use of lintel panels should be avoided whenever possible. Their use leads to additional panel elements and challenging connection details that can be more easily designed and detailed as part of a larger continuous panel.
- Panel shapes should be configured to eliminate the use of strongbacks whenever possible. Strongbacks reduce erection efficiency and in most instances can be avoided with proper planning during panelizing of the wall elevations.
- Ideally, the roof/floor framing connection point should be several feet away from the panel joint so there is not a concentrated load near the edge of a panel. If this is not possible, then the connection can be centered on the joint, so that the reaction is distributed equally between the two panels. The use of pilasters under concentrated reactions is not common but can be used when needed to accommodate large reactions. Typically, integral column strips with added reinforcing are used.

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Roof Connections

Roof System Connections

- Joists
- Decking to Joists

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Engineering Tilt-Up

Introduction

Determining the Wall Panel Thickness:

- For preliminary design purposes it is always desirable to estimate the wall panel thickness. Since the unbraced height-to-thickness ratio of most panels will fall between about 40 and 50 (up to 65 when double mats of reinforcement are used), an easy rule of thumb is that the panel structural thickness in inches will be about one fourth of the unsupported height in feet.

  For example, if the distance from the floor slab to the roof diaphragm is 24 ft, the panel structural thickness should be about 6 in. The actual design thickness must be determined as required by actual load, architectural, and construction conditions. Increased gravity loads, high lateral loads, prescriptive seismic detailing, reveals or other architectural features, the quantity and size of openings, and considerations related to lifting the panels may dictate a greater thickness.

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Engineering Tilt-Up

Introduction

Determining the Wall Panel Thickness (continued):

- Many engineers consider the minimum practical panel thickness to be 5 ½-inches for commercial projects. However, thinner panels have been used successfully on many smaller scale projects.
- Some designers and contractors also prefer a minimum of 1-inch cover because if the project is constructed during the heat of summer, the bar will flash the concrete (if the bar gets really hot) and shadows of the rebar lines will appear on the surface of the wall panel.
- In the past, panel thickness was set to match common dimension lumber sizes for efficient use of the forming. For example 5 ½" thick panels used a 2 x 6 edge form and 7 ¼" panels were formed using 2 x 8 material. While this is still a common practice in some areas, the advent of new forming systems has tended to minimize this consideration. When optimizing the tilt-up panel design, the cost of the forming is just one of the many variables that should be considered.

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Reveals and Chamfers

- Application
  - Adhesives
  - Screws
  - Nails
- Chamfer Edges to Avoid Corner Damage
- Reveal Depth
- Thinnest to Meet Design of Architect
- Must Consider Depth in Structural Design
- Use Reveals for Transition Between Finishes

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Reveals and Chamfers

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Structural Connections: Base

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Tilt-Up Concrete Association

- Networking
- Education
- Technical Support
- Resources
- Standards
- Certification
- Recognition
- Referrals

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Thank You!

This concludes the Continuing Education Program.

Any Questions?

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