OBJECTIVE SHEET

TILT-UP PANELS, PRECAST AND POST-TENSIONED CONCRETE

9

INTRODUCTION

Tilt-up construction has been around since the turn of the twentieth century. However, in recent years it has become an extremely popular form of constructing, not only warehouses and industrial buildings, but schools, churches, and office buildings. Innovations in construction and lifting techniques have made tilt-up construction a quick and economical choice for builders. Architects have a wide range of colors, textures, and decorative features from which to choose. Many of these features are created by skilled cement masons through the use of exposed aggregate, form liners, and mechanical tooling of the surfaces. If you have the opportunity to work on a tilt-up construction crew, you will have the chance to use all of the skills you have learned as an apprentice.

FOCUS ASSIGNMENTS

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1. Browse the website of the Tilt-up Concrete Association at www.tilt-up.org.

2. Click on the link ot the benefits of tilt-up and review the content. Your instructor will lead a discussion on tilt-up techniques and its use in your community.

UNIT OBJECTIVE

After completing this unit you will show the following competencies by mastering the activities on the Assignment Sheets and by scoring at least 85% on the written test.

SPECIFIC OBJECTIVES

1. List key points in the history of tilt-up construction.

2. Research key points in the history of tilt-up construction. (Assignment Sheet 1)

3. State advantages of tilt-up construction.

4. State common application of tilt-up construction.

5. Research common application of tilt-up construction. (Assignment Sheet 2)

6. List safety guidelines for working with tilt-up.

7. Research safety guidelines for working with tilt-up. (Assignment Sheet 3)

8. Arrange in order the steps in the tilt-up panel project.

9. Name the key points in planning a tilt-up panel.

10. State guidelines for applying bond breakers.

11. Name the steps in forming a tilt-up panel wall.

12. Explain the process of reinforcing panels.

13. Explain the process of installing embeds and inserts.

14. State guidelines for pouring the wall.

15. State ways to finish the tilt-up wall.

16. List steps in the process of erecting the wall.

17. Explain the purpose of post-tensioning.

18. State common applications of post-tensioning.

19. Identify advantages of post-tensioning.

20. State the purpose of precasting.

21. List the advantages of precasting.

22. State common uses of precasting.

23. Research the production of precast concrete panels. (Assignment Sheet 4)

INFORMATION SHEET

TILT-UP PANELS, PRECAST AND POST-TENSIONED CONCRETE

9

OBJECTIVE 1

List key points in the history of tilt-up construction.

Concrete has been used for over 2,000 years. There are records of Roman builders using concrete construction. In the 20th century, however, it became more feasible after the invention of reinforced concrete. Builder Robert Aikens is credited for one of the first tilt-up wall constructions in 1908. Aikens used a method called the tilt table. Panels were constructed on a horizontal table which was tilted into a vertical position. He constructed several buildings using this method and eventually attracted other builders. In the 1950's the tilt-up industry began to grow and become more widespread. This growth in the use of tilt-up construction was advanced by the following factors:

Photos courtesy of Tilt-up Concrete Association.

- Ready mixed concrete
- Availability of truck cranes
- The post WWII demand for new construction

OBJECTIVE 2

Complete Assignment Sheet 1.

OBJECTIVE 3

State advantages of tilt-up construction.

✔ **NOTE:** The Advantages of tilt-up are greater in buildings of 10,000 square feet consisting of 20 foot or higher walls.

- **More economical** — requires less scaffolding and formwork

- **Speedy construction** — panels can be tilted and braced in less than ten minutes. Complete buildings can often be constructed in 30 days or less.
- **Less maintenance**
- **Fire resistant** — concrete is noncombustible
- Panels can be easily removed and relocated
- **Opportunity for a variety of designs** — numerous exterior finishes can be used on tilt-up panels
- **Resistant to vandalism and theft**
- **Durability**

OBJECTIVE 4

State common applications of tilt-up construction.

Tilt-up panels have been primarily used for low rise commercial buildings such as warehouses, but builders are now using them to create a variety of structures including churches, parking garages, schools and theatres. They are now commonly used for two to four story structures as well. The only difference between the multi-storied tilt-up wall and the one story is that the panels weigh more and more wind bracing is required. Furthermore, the use of tilt-up for towers is a recent development because of their resistance to inclement weather such as high winds, hurricanes and tornadoes. Not all buildings are suitable for tilt-up panels, however. Consider the following requirements when choosing tilt-up.

Photos courtesy of Tilt-up Concrete Association

- The floor surface should be flat, and approximately equal to the wall surface.

- The wall panels should sit on the foundation and be less than about 40-45 ft. high.

  ✔ **NOTE:** Fifty foot panels are becoming common. Panels over 40-50 ft. in height must be thicker to withstand the stresses of lifting. Keep in mind, however, that three and four story tilt-up buildings are not uncommon.

- The panels should not exceed crane capacity. As a general rule, the panel should weigh no more than 80,000 lbs or cover about 900 square feet.

  ✔ **NOTE:** A crane with a capacity of 2-3 times the largest panel is required.

OBJECTIVE 5

Complete Assignment Sheet 2.

OBJECTIVE 6

List safety guidelines for working with tilt-up construction.

- Hire experienced vendors to design tilt-up projects.
- Review safety precautions.
- Personnel should be experienced in the construction of tilt-up.
- Insure that all structural connections are in place.
- Do not remove braces until instructed to do so by the engineer of record.
- Inspect the site for hazardous areas that could endanger the crane and operator.
- The crew should never stand beneath panels while they are being lifted.
- Workers not involved in the lifting process should stay clear of the lifting area.
- Attach all weld plates immediately when the walls are positioned.

OBJECTIVE 7

Complete Assignment Sheet 3.

OBJECTIVE 8

Arrange in order the steps in the tilt-up panel process.

1. Planning, design, and layout
2. Forming panels
3. Reinforcing panels
4. Installing embeds and inserts
5. Pouring the concrete
6. Finishing the panel
7. Erection of panels

OBJECTIVE 9

Name the key points in planning a tilt-up project.

WORDS YOU SHOULD KNOW

stack casting pouring a panel on top of another panel

Photos courtesy of Tilt-up Concrete Association

The planning of a tilt-up structure resides mostly with the engineer. Planning and design, for the most part, is not the job of the one who is constructing the structure. Builders should hire reputable, dependable engineers to design the tilt-up structure.

- Hire an engineer who has experience with designing tilt-up walls.
- Evaluate the site to determine available space for construction and movement of panels.
- Plan method of working with the available space.

- Prepare a sketch to show the sequence of pouring and erection of the tilt-up panels.

- Decide whether the wall should be prepared on the slab, on a casting slab, or by stack casting.

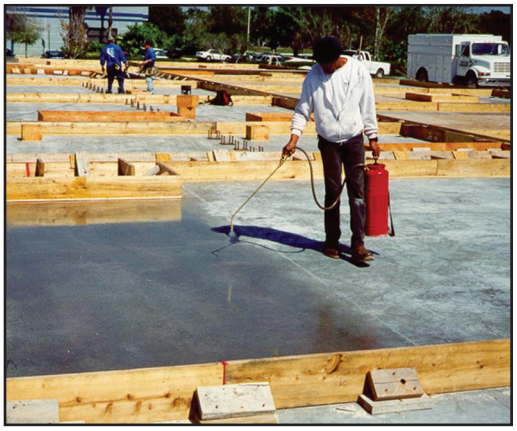
  ✔ **NOTE:** If the construction site is not large enough for the preparation of panels, the panels may be prepared on the slab. The process described here is of one constructed on the slab.

OBJECTIVE 10

State guidelines for applying bond breakers.

Before casting the tilt-up panel, bond breaker is applied to the floor slab to keep the panel from sticking to the floor slab. The rate of application is dependent on numerous factors. For example, the type of finish used on the floor surface must be taken into consideration. Also, application will be different if the floor is sealed prior to casting the panels. The following are guidelines for applying the bond breaker (Figure 1).

FIGURE 1



Photos courtesy of Tilt-up Concrete Association

- Use quality products.

  ✔ **NOTE:** Do not try to cut corners by buying cheaper bond breakers. The bond breaker is one of the most important chemicals used on the job.

- Follow all manufacturers' instructions when applying bond breakers.

  ✔ **NOTE:** Verify that the bond breaker is compatible with the curing compound and other chemicals and products that may come in contact with it.

- Use dependable cement masons experienced in applying bond breaker.
- Insure that the bond breaker is applied evenly. Two thin coats are preferable to one heavy one.
- To ensure good coverage, the second application should be applied at a right angle to the first.
- Place reinforcing steel and inserts as soon as the final coat has dried.
- Since wood absorbs bond breakers at a different rate than the slab, use a wood sealer on wood surfaces (such as reveal strips) to even out the coverage of the bond breaker.

  ✔ **NOTE:** Many regulatory agencies such as the EPA have strict guidelines for the use of solvent-based chemicals and spillages. Contractors may receive costly fines for violating these guidelines. Refer to the website www.epa.gov.

OBJECTIVE 11

Name the steps in forming a tilt-up panel wall.

WORDS YOU SHOULD KNOW	
cant strips	an insert placed inside of the form that creates a curved or triangular decorative feature after the forms are removed

1. Snap a chalk line on the slab to mark the panel perimeters. (Forms should be placed against the lines.) Mark the side of the line where the form should be placed, or snap a line on each side of the form.

2. Anchor form to the slab with a wood or steel support (Figure 2).

FIGURE 2

Photos courtesy of Tilt-up Concrete Association.

3. Install cant strips at the juncture of the side form.

4. Caulk corners to stop leakage of concrete.

OBJECTIVE 12

Explain the process of reinforcing panels

WORDS YOU SHOULD KNOW	
rebar	steel rod that provides tensile reinforcement for concrete panels

1. Tie the steel in the panels with spacing identified in the engineering drawings or reinforcing shop drawings.

2. Use plastic support chairs to attach grids (steel grids may rust) (Figure 3).

FIGURE 3

Photos courtesy of Tilt-up Concrete Association.

✔ **NOTE:** For steel grid use standard grade 40 or 60 rebar.

OBJECTIVE 13

Explain the process of installing embeds and inserts.

Embeds are steel plates with metal fittings that are embedded in the panel to attach to the footing, roof or other panels. Inserts are points used to attach hardware and braces for lifting.

1. Attach embeds to the side forms or wire to reinforcement. (Figures 4 and 5)

FIGURE 4

Photos courtesy of Tilt-up Concrete Association.

FIGURE 5

Photos courtesy of Tilt-up Concrete Association.

2. Install inserts according to the supplier's recommendation. The supplier is responsible for providing insert locations with descriptions provided by the engineer.

OBJECTIVE 14

State guidelines for pouring the wall.

✔ **NOTE:** The methods of pouring concrete for tilt-up panels are the same as those for floor slabs.

- Clean the base slab, using compressed air to blow away debris.

  ✔ **NOTE:** Refer to C.F.R. 1926.302 (b) (4) regarding the use of compressed air for cleaning.

- Remove any standing water.

- Apply bond breaker as described in objective 10.

- Ensure that the concrete mix meets specifications.

- Use direct chute placement where practical (Figure 6).

FIGURE 6

Photos courtesy of Tilt-up Concrete Association.

- Observe weather conditions. For cold weather, have insulation blankets available. If rain is possible either delay pour or have a cover for the panels. On hot or windy days, cure the panels with water misting or by using a curing compound.

- Vibration is important to consolidate concrete around pick points, embeds, rebar, and post tension cables.

- Finish the surface (Figure 7).

FIGURE 7

Photos courtesy of Tilt-up Concrete Association.

- Apply curing compound.

OBJECTIVE 15

State ways to finish the tilt-up wall.

A variety of finishes are available to enhance the appearance of tilt-up panels.

- **Trompe I'oeil** – This is a French expression that translates as "fool the eye." It's a method that creates a three-dimensional effect with the use of reveal strips and/or painting.

- **Exposed Aggregate** – This finishing method creates a pebbled effect by using light sandblasting to remove the surface concrete paste, exposing the aggregate. This effect can also be obtained with the application of chemical retarders to the slab surface which slows the curing of the surface paste. The paste is removed after erection with a high pressure wash (Figure 8).

FIGURE 8

- **Exposed Stone** – Unlike sandblasting, this aggregate finish is done by hand. Rocks and stones are placed on the casting surface over a thin layer of sand. Concrete is then placed over the rocks and sand (Figure 9).

FIGURE 9

- **Colored and Textured Paints** – The most common and inexpensive choice for finishing the tilt-up panel surface. Requires two coats and a primer. For darker colors a third coat is recommended.

  ✔ **NOTE:** The surface cannot be painted until the walls are cured and the bond breaker is removed.

- **Cast-In Features** – Nesting brick and thin concrete block systems are placed on the floor slab and embedded in the face of the panel (Figure 10).

FIGURE 10

- **Bush Hammering** – A less-common method of finishing uses a bush hammer fitted with a variety of attachments. This method is used on concrete constructed with softer aggregate. The area around corners should be worked with hand tools to avoid damage. A minimum concrete age of 14 days is recommended to avoid damage by loosening of the aggregate.

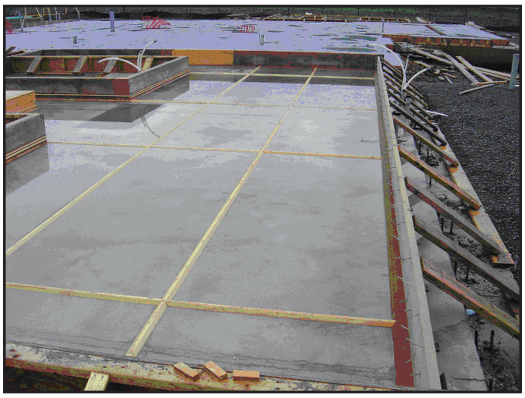
- **Sand Bed** – This method involves the hand placement of large aggregate over a layer of sand within the form. Concrete is then placed over the aggregate and sand within the form.

- **Accent Features** – Champhers and reveals are especially well suited to tilt-up construction because of their low cost and relative ease of creating eye-pleasing shapes. Wood and rigid plastic are the preferred materials for creating these accent features (Figures 11-13).

FIGURE 11

FIGURE 12

FIGURE 13



- **Form Liners** – These can be manufactured or created from other building materials such as corrugated siding or metal decking. Form liners can be used to create accent features or intricate designs (Figure 14).

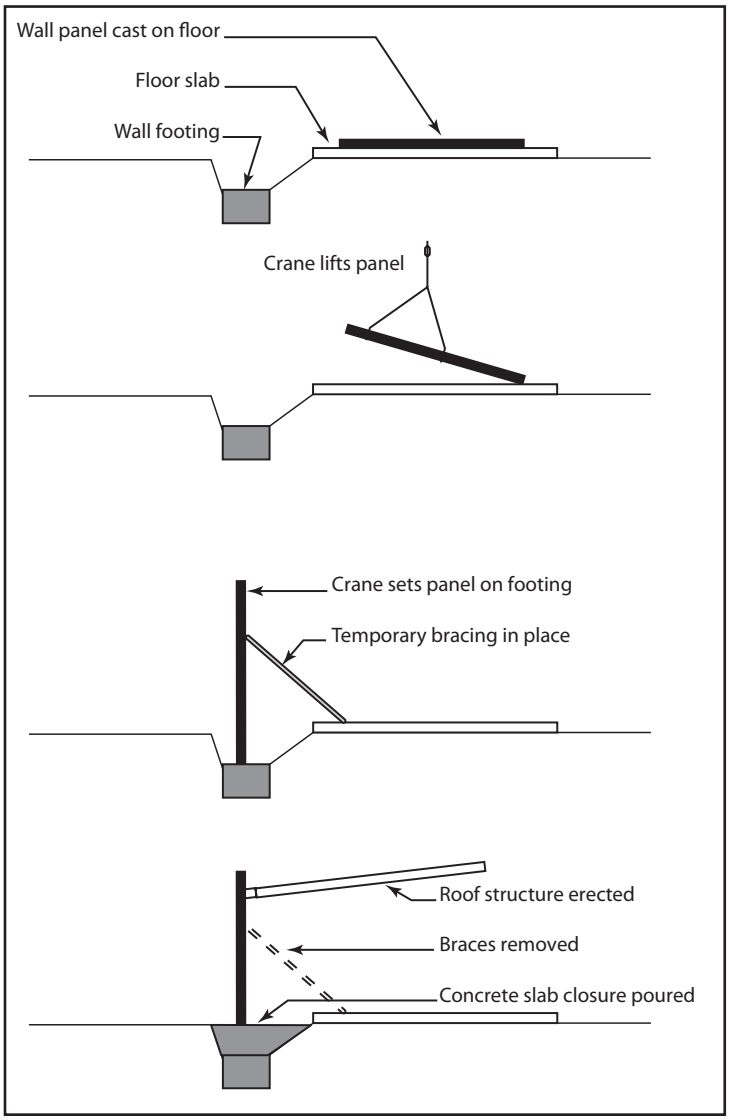
FIGURE 14

OBJECTIVE 16

List steps in the process of erecting the wall.

WORDS YOU SHOULD KNOW	
rigging	all equipment required for lifting and putting panels into place
spreader bar	a beam to which cables are connected for lifting the tilt-up panel

FIGURE 15



The process of lifting a wall panel into place involves the following steps:

✔ **NOTE:** Lifting of panels should be done by qualified, experienced riggers.

1. Discuss the procedure and the safety precautions with the crew

2. The crane operator lowers the spreader bar, then the rigging crew connects the cables to the pickup inserts.

3. The rigging crew straightens tangles in the cables.

4. The foreman signals the crane operator to begin the lift.

5. The crane operator lifts the panel and sets it on the prepared grout pads or shims (Figure 16).

FIGURE 16

Photos courtesy of Tilt-up Concrete Association.

6. The riggers move the panels to the snap lines.

7. Braces are installed to protect the panel against high winds and to plumb the panel; weld all weld plates immediately when walls are put into position (Figures 17-19).

FIGURE 17

FIGURE 18

FIGURE 19

8. The crane operator loosens the cable and the riggers disconnect the lifting equipment from the wall.

OBJECTIVE 17

Explain the purpose of post-tensioning

WORDS YOU SHOULD KNOW	
tendons	pre-stressed steel element used to reinforce concrete

Post tensioning is a way of reinforcing concrete and concrete structures. It takes advantage of some of the properties of concrete and the materials used to reinforce it. Concrete is very strong in compression. That is why it is often used as a base for building homes, large buildings, and other structures. Pouring a concrete slab and placing something heavy on it takes advantage of its compressive strength.

However, concrete is not very strong in tension. An example of tension would be if a concrete column were placed on its side, like a log across a stream, and a weight applied to the center. An unreinforced column would break in half.

Metal reinforcing rods are very strong in tension and resist bending or breaking in half. When they are combined, concrete and metal reinforcing material, the structure benefits from the strength of both materials.

In a typical post-tension project, the steel strands or tendons are placed in the formwork of the slabs or walls. The steel is encased in a sheathing that allows it to move inside rather than bond directly to the concrete (Figures 20 and 21).

FIGURE 20

FIGURE 21

After the concrete is poured and hardened, hydraulic jacks at either end are used to tension the cable and it is then anchored in place for the lifetime of the structure.

This places the concrete in compression, taking advantage of one of its inherent strengths (Figure 22).

FIGURE 22

A post-tension foundation allows a great deal of weight to be applied in building construction. It is especially useful for the construction of parking garages and bridges.

OBJECTIVE 18

State common applications of post-tensioning.

Though post-tensioning is widely used in building construction, it is particularly useful in structures that must bear great weight. It is also an excellent reinforcement for buildings in seismic areas and is highly resistant to inclement weather. Buildings constructed with post-tensioning withstand strong winds, tornadoes, and hurricanes more effectively than concrete construction that uses conventional reinforcement. Post-tensioning is frequently used as reinforcement for the following structures:

- **Parking Garages**
  - ❏ Builders commonly use post-tensioning tendons for parking garages because it allows for more flexibility in ramp design, span lengths and column layout.
- **Bridges**
  - ❏ Post-tensioning makes possible the construction of bridges with complex geometrical requirements. Long span bridges, for example, can be built without temporary structural supports.
- **Stadiums**
- **Water tanks**
- **Towers**

OBJECTIVE 19

Identify advantages of post-tensioning

In conventional concrete construction, rebar is embedded in the concrete as reinforcement to limit cracking. This method of reinforcement is called "passive" because it only has force when the concrete has already cracked. Post-tensioning tendons are referred to as "active" reinforcing because they minimize cracking. Prestressing the tendons strengthens the structure making it more resistant to cracking than conventional rebar construction.

- Longer cleaner spans
- Thinner slabs decrease the amount of concrete needed
- Fewer beams
- More slender, dramatic elements

OBJECTIVE 20

State the purpose of precasting

WORDS YOU SHOULD KNOW	
casting bed	the forms and supports used to build panels for tilt-up walls or precast members

Precast is a method of preparing concrete members prior to their use. They may be constructed then transported to the job site. Or they may be constructed on the job site then stockpiled. The latter is preferable because of the difficulties of transporting. If stockpiled, it is important to have a place to store the pre-cast pieces on the job site.

OBJECTIVE 21

List the advantages of precasting

✔ **NOTE:** When concrete pieces are produced in a plant, the manufacturer has more control over the entire production process than on-site construction.

- Cost efficient
- Less weather interference
- Faster construction
- More quality control

OBJECTIVE 22

State common uses of precasting

✔ **NOTE:** Almost all cast-in-place structures can be precast.

- Concrete beams
- Concrete walls and partitions
- Floor and roof decks

OBJECTIVE 23

Complete Assignment Sheet 4.

TILT-UP PANELS, PRECAST AND POST-TENSIONED CONCRETE

Name _____Score_____

OBJECTIVE 2

Research key points in the history of tilt-up construction.

BASIC SKILLS


Reading


Writing

EQUIPMENT AND SUPPLIES

- Pen or pencil
- Paper

INSTRUCTIONS

Research a period in the history of tilt-up construction that interests you.

- Find information about the period by using Internet and library sources.
- Answer the following questions in writing or as a presentation to the class as your instructor chooses.

1. What period did you choose?

   _____

2. Why does this period interest you?

   _____

   _____

   _____

   _____

   _____

   _____

   _____

3. During this period what were the primary uses of tilt-up panels?

4. How has tilt-up construction improved since this period?

TILT-UP PANELS, PRECAST AND POST-TENSIONED CONCRETE

Name _____Score_____

OBJECTIVE 5

Research common application of tilt-up construction.

BASIC SKILLS


Reading


Writing

EQUIPMENT AND SUPPLIES

- Pen or pencil

INSTRUCTIONS

Explore Internet tilt-up sites to research the variety of buildings constructed with tilt-up. Answer the following questions about your research.

1. What information sources did you use?

_____

_____

_____

_____

2. Identify the types of buildings constructed with tilt-up.

_____

_____

_____

_____

3. Describe the variety of buildings constructed with tilt-up.

ASSIGNMENT SHEET 3

TILT-UP PANELS, PRECAST AND POST-TENSIONED CONCRETE

9

Name _____Score_____

OBJECTIVE 7

Research safety guidelines for working with tilt-up.

BASIC SKILLS


Reading


Writing

EQUIPMENT AND SUPPLIES

- Pen or pencil

INSTRUCTIONS

Visit the Occupational Safety and Health Administration website at <www.osha.gov>. Review the safety regulations about concrete construction and identify specific regulations for the following steps in the tilt-up construction process.

1. Use of equipment

_____

_____

2. Reinforcing panels

_____

_____

3. Preparing for a lift

_____

_____

4. Lifting panels

_____

_____

TILT-UP PANELS, PRECAST AND POST-TENSIONED CONCRETE

Name _____Score_____

OBJECTIVE 23

Research the production of precast concrete panels.

BASIC SKILLS

EQUIPMENT AND SUPPLIES

- Pen or pencil

INSTRUCTIONS

Visit the National Precast Concrete Association website at <www.precast.org>. Research the production of precast concrete panels and answer the following questions.

1. What structures are commonly constructed with precast panels?

_____

_____

_____

_____

_____

2. What are the common reasons that builders choose precast concrete forms?

_____

_____

_____

_____

_____