This data sheet discusses hazards specifically related to the tilt-up method of concrete construction. It also identifies precautions recommended for the prevention of injury and damage that may occur during the preparation and erection of precast panels. Problems related to casting operations are not discussed because they are similar to those found in other flat concrete work, such as during the construction of industrial floors and slabs on grade. Problems related to transporting precast panels from a casting yard to a structure are not included for the same reason.

1. Tilt-up construction is a method of erecting precast concrete wall panels and occasionally other structural units, such as roof bents or basement walls. It is adaptable to the erection of most types of structures, including multistory buildings, but has been used most extensively for one-story buildings.

Description of method

2. In the tilt-up construction method, the wall panels or other structural units are cast and cured in a horizontal position, usually at the building site with the bottom of each panel immediately adjacent to its ultimate position on the foundation. The panels are then tilted up to the vertical and secured in position by temporary bracing until permanent stabilizing features, as provided in the design of the structure, are installed. Intermediate and corner columns, when required, are generally formed and cast in place after placement of the panels.

3. The panels may be cast on the ground floor or on the upper floor immediately inside the building perimeter, or they may be cast in casting beds on the ground immediately outside the building perimeter. They also may be cast in stacks on a casting bed near but not adjacent to the building, or at a casting yard some distance from the building site. The advantage of casting in stacks is that temporary shelters can be erected and work can be continued, regardless of adverse weather conditions, such as rain or freezing temperatures.

4. Window and door frames are cast in the panels, or forms inserts are used to provide whatever openings are specified by the design. Electric outlet boxes and conduit generally are cast in the panels.
Hazards

5. The tilt-up method, as compared with the conventional or cast-in-place, has significant safety advantages because it makes possible a large amount of ground or floor level work and requires a minimum of concrete from work. However, the tilt-up method also presents hazards not found in the conventional method of concrete construction.

6. Hazards particular to the tilt-up method are encountered during the tilting operation while panels are being braced and, if necessary, when columns are being formed and poured. During tilting, the panel may collapse, the lifting attachments or the hoisting equipment may fail, or the panel may slide and drop off the foundation. These hazards will be minimized if a coordinated operation is carefully planned and executed, the panels are designed properly and adequate equipment is used. Quality control related to proper concrete strength at time of lift, placement of the reinforcement and use of properly sized inserts, is an additional control factor required to reduce the frequency of insert pullouts.

Design

7. Tilt-up concrete construction should be used only when it has been planned for in the design of the structure.

8. During tilt-up procedure, the panel is subjected to stresses of up to four times the magnitude for which it was designed as a wall section. Consequently, the panel must be designed with load-bearing qualities enabling it to withstand both kinds of stresses, or it must be provided with the stiffening necessary to offset the stresses encountered during the tilting operations (see Figure 1).

9. Details for lifting and bracing the panels should be included by the accessory supplier and furnished to the contractor. If the contractor’s method differs from the accessory supplier’s details, the contractor should consult with the supplier and the erection contractor to determine the adequacy of the alternate methods before proceeding with the work.

Figure 1 Several types of commercially available pick-up inserts, brace anchors, and adjustable brace hardware are shown here.
10. The design should specify the exact locations of the inserts or anchors for attachment of the crane rigging, strong backs, additional reinforcing steel and the braces that maintain the panels in an upright position after they are set. The supplier’s details and instructions should show the methods for embedding and reinforcing the inserts or anchors in the panels. Inadequate design may result in failure and collapse of the panel during the tilting operation. For sections made from lightweight concrete, the safe working loads of inserts must be calculated using a reduction factor of 0.75.

11. Other design factors to be considered are the strength and stability of the supporting surface. Failure of the surface, under the combination weight of the equipment and the panel, may cause loss of control and dropping of the load or even overturning of the equipment. This is particularly true with large panels and high point loads under outriggers or tracks.

12. If raising is to be done outside the structure, the bearing quality of the soil must be determined, and if necessary, the design must specify a way to prevent side tipping, sinking or slipping of the equipment. Mats or stabilized ramps should be used to provide stability. Outriggers on truck cranes should be used as directed by the manufacturers. Working surfaces should be capable of handling a fully extended crawler crane or truck crane with outriggers fully extended.

### Preparation and casting

13. When the panels are cast, it is important that the design specifications be followed exactly. The ground floor slab, specially prepared casting bed, or other smooth stable area may be used for the casting platform. If possible, brace anchors should have been cast in floor or slab when it was poured. Space must be allowed for transitmixed truck operation, crane operation and safe erection of the “walkout” panel.

14. The casting surface should be covered with a separation medium to prevent bonding of the casting surface and the panels, or a floor hardener should be deployed over the cured floor. The separation medium may be paper, plastic, metal or other sheet material, but usually a specially prepared curing and bond-breaking compound is used. When a liquid or separating medium is applied, the casting surface must be completely coated to prevent spot bonding between the casting surface and the panels. Both the bond breaker and the curing compound should be of the same brand to reduce the possibility of incompatibility. It is also important that the separating medium be kept off the inserts where bond is required.

15. The forms for the top and bottom edges of the panel must be kept in true alignment to ensure full bearing on the foundation, and to eliminate the necessity of “leveling up” through the use of wedges or blocks that would introduce “point support” of the bearing. Point support, in turn, may produce instability and the danger of collapse.

16. Where perimeter forms are removed from the panel, the setting edge should be inspected for irregularities and overcast edge lips. If such defects are found, they should be removed. Crushing of irregularities or edge lips will cause the panel to drop and collapse, or equipment failure may result.
17. Panel anchors or brace attachments should be inserted in the panels at the time of casting. The inserts or anchors for attaching the strong-backs, raising lines and brace connections must transmit their loads without pulling out and tearing loose from the panel or floor. These panel anchors and brace attachments must be of the size prescribed by the design. Good quality control techniques, at this stage, reduce the possibility of future incidents.

18. Inserts and anchors of various types are commercially available and their use is recommended. Makeshift inserts, anchors of questionable strength and improvised nailing blocks should not be depended on for bracing purposes.

Support system
19. Wall panels designed only for their function in the finished structure may not be self-supporting as simple beams when being raised from the horizontal casting position. Without additional reinforcing or a system for reducing the concrete stresses developed in the raising, they may rupture and collapse during the tilting operation. In order to prevent failure, the requirements for support specified in the design must be followed. The use of properly located strong-backs of steel, wood adequately anchored or strong-back shores is essential to brace most panels with openings or unusual configurations. Coupled with multiple-row and multiple-point pickups at the center of gravity of the panel, these devices should permit safe handling during erection. These procedures will protect wall panels of various types through the tilting operation, and are of particular value when sandwich wall panels are being handled.

20. A good support system prevents overstressing of the concrete by providing distribution of panel weight during raising. It also reduces the movements to be made by the equipment during the raising travel.

21. For small panels, which have enough strength to act as simple beams, a pair of pickup points provided by a pair of inserts located as high up in the panel as possible may suffice. In most cases, however, several points of support are advisable, both for protection of the panel and for the satisfactory distribution of the weight.

22. The support system may consist of:

- Inserts and lifting hardware to which the compensating (detail) rope can be attached
- A pulley and spreader bar properly located so the weight is automatically shifted to the bottom of the wall panel as it is raised
- Bolts secured in the concrete to which steel or wood strong-backs can be attached

Bracing and lifting
23. The maximum internal stress on the panel is usually encountered at approximately 30 to 50 degrees from the horizontal, except for edge lifting. As the panel is lifted or tilted, the dead weight of the panel induces flexural moment. Cohesion and impact are other considerations. As a result, strength of concrete at breakout is extremely important. A minimum of 2,500 pounds per square inch compression strength will satisfy most designs and pickup point locations.

24. Resistance to initial movement caused by the bonding of the panel to the casting surface, or by adhesion of the separating medium, may be overcome by using jacks to slightly raise the panels or to push them horizontally. By slowly breaking the bond, jacking reduces internal stress, and prevents whipping of the lines or bouncing of the panel or equipment that might occur with sudden separation of the panel from the casting surface. If panels are wedged free prior to erection, be sure that the wedges are inserted along a line where inserts are situated to avoid overstressing the panel.

25. After the panels are raised and placed, but before the raising lines are released, the panels must be
secured in the vertical position by temporary bracing. The panels must be maintained in the vertical position during installation of the permanent stabilizing features, as specified in the design.

26. The bracing must provide resistance against horizontal pressures, such as those exerted by high winds acting on the sides of the panels. Several factors, such as panel size and configuration, must be considered in computing the possible wind load in order to determine the correct bracing. Consult the model building codes applicable to your area. The wind load on a panel is expressed in pounds per square foot and the model codes for construction contain conversion charts. Unique locations, such as hurricane areas, the Columbia River Gorge and the Gulf Coast require support in addition to that required by the codes. Only about 5 percent of the projects built today involve bracing on both sides. Any brace longer than 16 feet needs an intermediate knee brace. Manufacturer’s recommendations must be followed. Where a knee brace is required, both lateral and end braces are recommended.

27. The panel should be braced to at least two-thirds of its height by a brace that forms, preferably, a 3-4-5 triangle. Although some suppliers recommend a steeper angle than this, the resistance of the brace decreases as the cosine of the angle. A minimum of two braces should be applied to each panel section. If the size of the panel requires it, a third brace should be placed. Braces that are damaged or deformed should not be used and the correct size and number of adjusting pins must follow the manufacturer’s recommendation. To speed up installation, the braces should be attached to the panel prior to erection.

28. Under no circumstances should the top brace connection be made from the underside of a partly raised panel. Tag lines on the top of the panels will help steady and control them until bracing is completed.

29. Whenever possible, braces should be attached to the panels before raising begins, so that the attachments need not be made from a ladder. If ladders must be used, they should be supported to prevent side movement or slipping. Some contractors have found gooseneck ladders that can be hooked over the top of the panels more satisfactory than step-ladders or other type ladders.

30. Employees should not be permitted to climb on reinforcing dowels, crane parts, or other makeshifts to attach braces or to remove the support system. Rolling scaffolds, with attached ladders and handrails, are recommended where practical. Workers should not remain on such scaffolds when they are to be moved.

31. Suitable and adequate lifting equipment must be used for successful and safe tilt-up erection. The type of equipment selected will be determined by the building structure and design; size and weight of the panels; schedule and plan of erection sequence; and other factors. Familiarity with the job, talking with the crane contractor and proper planning can greatly improve most jobs. Prior to making any lifts, the rope lengths need to be verified to assure inserts will not be overloaded.

32. The most common type of power equipment used for lifting panels is a mobile crane. Other kinds of hoisting equipment may be used, but will not provide the flexibility of self-propelled units.

33. The capacity of the crane or other hoisting unit at the maximum radius required during the raising should not be less than twice the panel weight of the largest panel to be lifted and the accessories needed for the task.

34. Regardless of what lifting arrangement is used, the lifting lines should be kept vertical during the tilting operation to reduce strain on the equipment and to counteract the tendency of the panel to slide.
35. One individual should be designated to give signals and the crane operator should interact only to that individual’s signals, except that anyone may give an emergency stop signal. Need to be careful. There are standard signals used internationally and both the crane operator and signalman must be trained. The signal person and the crane operator should agree in advance about the signals to be used so misunderstandings are prevented and to ensure proper control of the load. Misinterpretation of signals can lead to serious injuries and extensive property damage.

36. Positive measures should be taken to prevent contact with, or damage to, overhead installations, such as utility lines or projections from adjacent structures. Utility lines may be temporarily relocated if there is not an alternative method of protection. However, such relocation should be done by the utility company concerned.

37. All personnel should be instructed about, and be required to stay away from, suspended loads and should be kept out of the line of fall of loads and booms. Bracing and lifting operations demand a high degree of teamwork. Each person on the team must completely understand the job and be prepared to carry out this part of the operation in a safe manner.

Personal protective equipment

38. All personnel working around the erection area should wear the necessary personal protective equipment, especially safety hats, safety footwear, high vis vests. Adequately sized pinch bars and other equipment necessary to perform this work need to be provided. Proper wrenches and properly planned access will help ensure good production.

Sources of information

American Concrete Institute 38800 Country Club Dr.