



Precast Concrete Panels-Hazardous Storage

Safety and Health Information Bulletin

02-10-2004

Purpose

The purpose of this Safety and Health Information Bulletin is:

1. To alert concrete panel manufacturers that finger rack storage systems for concrete panels need to be designed with sufficient capacity and strength to prevent panels from tipping over;
2. To encourage the development of installation and storage procedures; and
3. To encourage employers to provide training concerning, and to enforce work rules regarding, the installation and storage procedures.

Background

The Denver Area Office investigated a fatal accident involving the tip over of concrete panels stored in finger racks at a concrete panel manufacturing facility. The concrete panels are flat panels of various sizes and thickness and are commonly used as concrete sound barrier walls or as reinforced concrete retaining walls. The panels generally are not strong enough to be stored flat, and therefore they are commonly stored in an upright position using finger racks or other storage systems.

Finger Rack Storage System

The finger rack system involved in the accident was built with two horizontal steel tubes about 80 feet long with 1.25 inch diameter holes spaced along the tube length. The top tube (6-inch square) was

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supported about 5.25 feet above the ground surface using the same size steel vertical tubing and diagonal braces. The second tube (4-inch square) was similarly secured about midway between the top tube and the ground surface.

After the panels are manufactured and partially cured, they are stored in the panel racks for additional curing time until ready for shipment. The panels are hoisted into the racks for storage using a forklift or a crane. When positioned in the finger racks, the panels may or may not be supported underneath by wooden members (dunnage) to level the panels. The panels are positioned close to the finger rack (typically within ½-inch) and held in a nearly upright position using 20-inch-long, number 7

rebar pins that are inserted into the finger rack holes (see figure 1). A single pin can be used on both sides of the finger rack such that the pin is normally positioned to extend out only about 6-7 inches on each side of the square tube. Wooden wedges, of variable widths and thicknesses, are positioned and hammered between the panel and the pins to further secure the panel in an upright position.

The pins used at the site were made of grade 60 billet steel (60-ksi yield strength). Some of the pins used were bent, indicating that they were undersized. The pins did not have any retaining mechanism to prevent the pins from being pushed through the tube holes or for ensuring the pins were inserted the proper distance.

Incident Description

On the day of the accident, all the panels in the rack tipped over which resulted in the collapse of the entire system (80 feet long). While all of the factors that caused the panels to tip over have not been identified, there were no wind or weather conditions that would account for the tip over. Two employees were instructed to secure panels in the other racks. Approximately three hours after the first tip over, one of the two employees was fatally injured when five panels tipped over. The panels involved in these collapses were typically 12 feet high by 8 inches thick, varied in length from 23 feet to about 25.5 feet, and weighed over 13 tons each.

Other Information

The accident investigation revealed that the panel tip overs were partially due to the inadequate design of the finger rack system and to improper storage procedures for the size and configuration of the panels involved. The finger rack was installed and being used without any engineering design that specified the rack capacity and procedures for its use. The rack system should have been properly engineered to prevent tip over in order to ensure the safety of the personnel around the stored panels and to prevent damage to the panels.

Recommendations

Employers should ensure that finger racks are designed with sufficient strength for the safe storage of concrete panels and are used in accordance with their design. Some methods to improve rack stability include:

1. Increase the diameter and/or strength of the rebar pins such that they are less subject to permanent bending during use.
2. Place dunnage under each and every panel in at least two locations (each within two feet of each end of the wall panels) to help prevent twisting motions that could cause the panel to tip and/or cause the wedges to come loose.
3. Include specifications, such as the size, thickness, and length of the steel horizontal restraining members. They should be rigidly attached to the rack.
4. Secure the wedges to the pin to prevent them from falling out.
5. Include an additional tier rack near the top of the panels to provide additional support (see figure 2).
6. Design the pins so that they are of a consistent size and shape to ensure proper placement during installation (see figure 3), and that they are also restrained from horizontal displacement once installed. One way of restraining movement would be to install a clevis pin.
7. Include additional holes in the rack to minimize the movement of the panels between the pins and minimize the number and sizes of the wedges needed (see figure 2).
8. Design the system and implement installation procedures such that if one panel tips over it does not cause adjacent panels to tip over.

9. Do not perform patching/finishing work on the panels while stored in the rack. Such activity should be performed in a separate area, where adequate support is provided for the additional stress that may be involved.
10. Mark the racks conspicuously to indicate design capacities (e.g. height, length and weight of panels).
11. Establish, communicate, and enforce proper storage procedures.
12. Ensure a professional engineer reviews and provides specific requirements (specifications) for the storage system and storage procedures of concrete panels.



Figure 1. Finger rack with inadequate rebar pin holding panels.
Also the pin is not properly placed



Figure 2. Higher tier finger rack.



Figure 3. Different types of pins.