



# Guardrail systems: Fall prevention for floor and wall openings and open-sided floors

One-third of all fatalities in the U.S. construction industry result from falls from elevations. Falls from elevations also cause many serious injuries resulting in significant time lost from work.

2. Unguarded floor openings, wall openings, platforms and open-sided floors expose workers to falls. Floor holes, although smaller openings, represent tripping and stumbling hazards. This data sheet focuses on measures to reduce and guard these types of hazards.

3. The most practical means for providing protection and preventing falls is the erection of guardrails along exposed edges or across openings such as stairwells, chute openings, hatchways, elevator shafts, skylights, duct and pipe openings, window and doorway openings, decks, mezzanines, balconies, and ladder openings. These openings are found on most construction projects and can be the cause of serious injuries if not guarded and maintained.

## Definitions

4. The following definitions conform to specifications in the American National Standards Institute, Standard A1264.I-1989, Safety Requirements for Floor and Wall Openings and (non-residential) Stair and Railing Systems. (note that all lumber dimensions are nominal lumber sizes.)

- a. Floor opening – An opening 12 inches or more in its least dimension in any floor, roof or platform, through which a person, material or tool may fall
- b. Floor hole – An opening less than 12 inches, but more than 1 inch in its

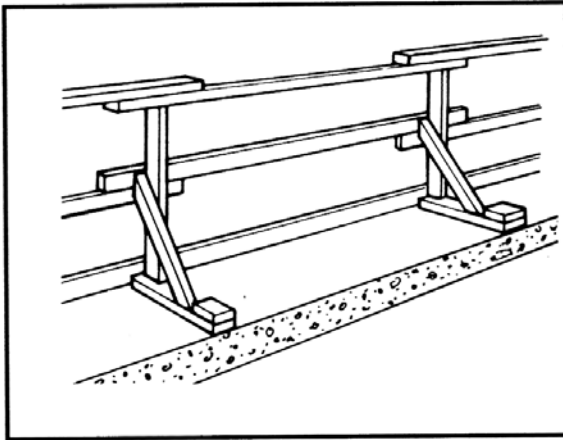
least dimension in any floor, roof or platform, through which materials or tools may fall

- c. Wall opening – An opening at least 30 inches high and 18 inches wide in any wall or partition, through which a person may fall more than 4 feet
- d. Open-sided floor – Any floor, deck or platform 6 feet or more above an adjacent floor or ground level with no barrier
- e. Guardrailing – A vertical barrier erected along the exposed edges of a floor opening, wall opening, open-sided floors or platforms to prevent personnel from falling
- f. Toeboard – A vertical barrier at floor level, erected along the exposed edges of a floor or wall opening to prevent materials or tools from falling

## Guarding floor openings and open-sided floors

5. All openings should be protected by a guardrail system consisting of a top rail, an intermediate rail, a toeboard and posts (Figure 1). The top rail should have a vertical height of approximately 42 inches (+/-3 inches) from the top rail surface to the floor. The top railing should have a smooth surface. An intermediate rail should be erected halfway between the top rail and the floor. A toeboard 4 inches in vertical height from the floor and securely fastened in place not more than 4 inches above the floor should be erected.

6. Most guardrails on construction projects are constructed of wood. The post stock should not be less than 2 inches by 4 inches



**Figure 1.** This guardrail system demonstrates how to protect an opening by using a top rail, an intermediate rail, a toeboard and posts. Note that the bracings are on the outside to avoid a tripping hazard.

*(Courtesy Construction Safety Association of Ontario)*

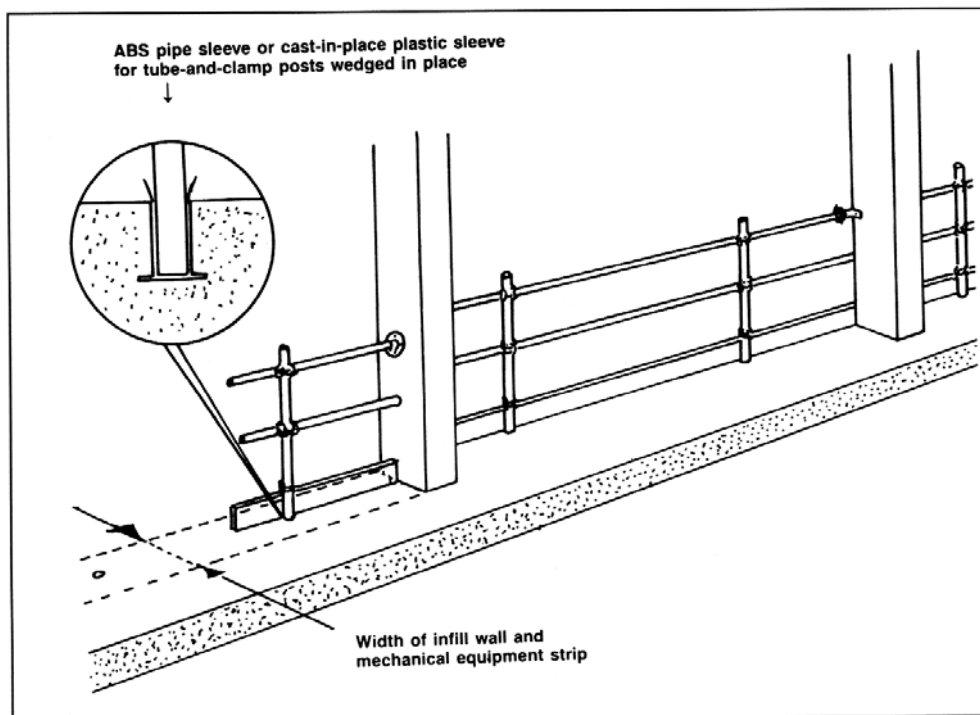
spaced no more than 8 feet apart. The top rail stock should be not less than 2 inches by 4 inches. The intermediate rail stock

should be at least 1 inch by 6 inches. The toeboard stock should not be less than 1 inch by 4 inches. The guardrail structure should be capable of withstanding a load of 200 pounds applied in any direction at any point on the top railing, with a minimum of deflection.

**7.** Guardrails also can be constructed of rigid materials, such as pipe or other metal members, or other materials meeting the prescribed strength standards (Figure 2).

**8.** Cable or chains, however, are difficult to maintain at the prescribed rail height without sagging, particularly when used as top railings; they also invite workers to use the top rail as a line to which lanyards can be attached.

**9.** The guardrail system must be inspected frequently and properly maintained when the hazard of a floor opening or wall opening exists.



**Figure 2.** Guardrail systems also can be fabricated from tube-and-clamp scaffold or equivalent components. This arrangement requires cast-in-place sleeves to accept the posts.

*(Courtesy Construction Safety Association of Ontario)*

**10.** Also available are manufactured guardrail systems providing equivalent protection around floor and wall openings. However, it is important to note some manufactured systems require the building be designed to accommodate the guardrailings.

### **Guarding wall openings**

**11.** If the size of the opening indicates a wall opening, it should be protected by a top rail, intermediate rail and toeboard. A solid barrier or a screen fully covering the opening also can be used. It may, at times, be necessary to erect the guardrails so they can be moved to permit materials and/or personnel to pass through the opening.

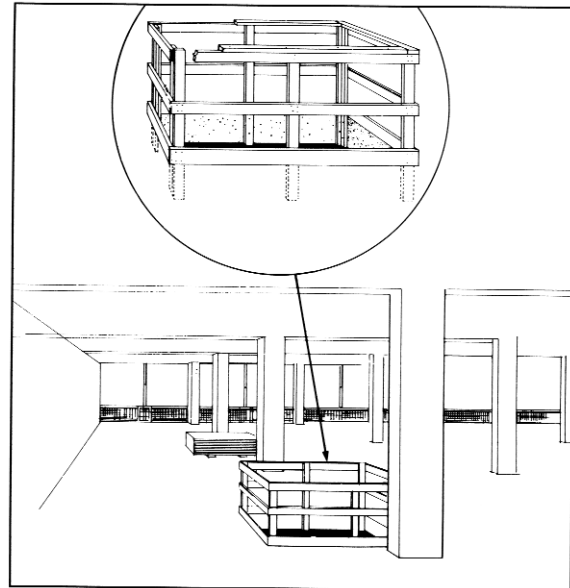
**12.** If a solid barrier or a screen is used, it must be secured in place and meet the loading requirements for guardrails.

### **Guarding floor holes**

**13.** Because of size and location in narrow passageways, floor holes and openings are best covered over with material that is equal to the strength of the surrounding floor or surrounded by a guardrail (Figure 3).

**14.** Covers should be of 2-inch (scaffold-grade) plank or plywood of equivalent strength (exposure 1, class B), and at least 3/4-inch thick. The cover must be secured in place to prevent movement or lifting. Movement can be prevented by constructing a frame of two-by-fours fitting the inside measurements of the hole (Figure 4). Nail the frame to the planks or plywood, and fit the assembly in the opening. Feather the edges of the covers to reduce the likelihood of tripping. To prevent lifting, secure the covers with nails or concrete fasteners.

**15.** When using plywood as covers, it is recommended the plywood be recessed so the cover is level with the floor. This will



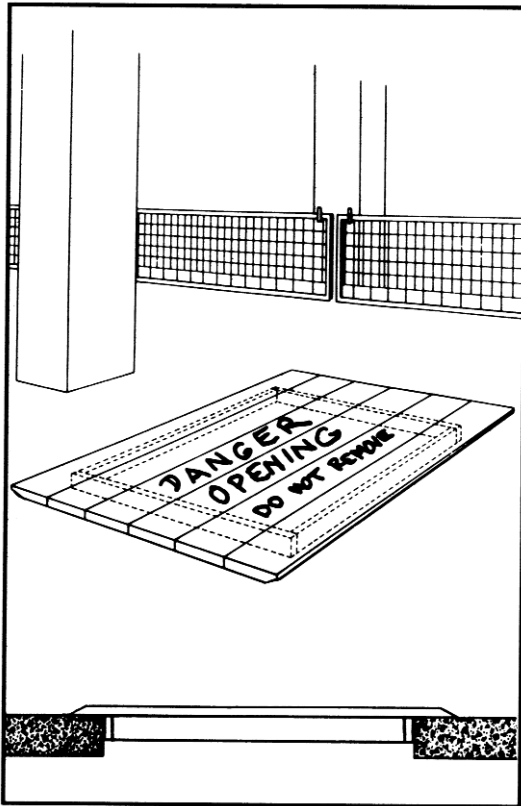
**Figure 3.** Guardrails can be used to protect floor openings.

*(Courtesy Construction Safety Association of Ontario)*

reduce the possibility that the plywood will be lifted or pried loose, and taken away for other uses. Planning and preparation is required if recessing is the option.

**16.** Floor openings and hole covers must be identified. A warning sign in bright red letters reading, "Danger: Opening – Do not remove", should be placed and maintained on each cover as long as the possible hole hazard exists.

**Caution:** Whenever a railing or a cover is being installed or removed to perform work or move material, the exposed workers should be protected with a fall protection system, lifeline and/or lanyard attached to a body harness while this condition exists. No part of any type of a guardrail system should be used as an anchor point for a lifeline or lanyard. The guardrails are erected to withstand 200 pounds of pressure, whereas anchorage for lifelines and lanyards must sustain a load of at least 5,000 pounds.



**Figure 4.** Covers must be capable of supporting all loads to which they may be subjected without exceeding the allowable unit stress for the material used.

*(Courtesy Construction Safety Association of Ontario)*

Safety Engineers, 1800 E. Oakton, Des Plaines, IL 60018, 1991.

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"OSHA Up To Date." National Safety Council, March 1990.

Safety Requirements for Floor and Wall Openings (non-residential) Stair and Railing Systems, A1264.1-1989. American National Standards Institute, 1819 L St., N.W., 6th Floor, Washington, DC 20036, 1989.

## Acknowledgement

This data sheet was revised by the Construction Division of the National Safety Council, 1121 Spring Lake Drive, Itasca, IL 60143.

## Sources of information

Fall Protection Systems – A10.32-2004

"Accident Prevention Manual for Business & Industry, 2 vols, 10th ed.," National Safety Council, 1992.

29 CFR 1926.500, Safety and Health Regulations for Construction, Subpart M, Floor and Wall Openings. Department of Labor, Occupational Safety and Health Administration, Washington, DC 20210.

Construction Division News, American Society of



**Minimum specifications for guardrail systems**

<b>Type of material</b>	<b>Size of top/mid rail (inches)</b>	<b>Height (inches) Top rail (1)</b>	<b>Post size/spacing (2)</b>	<b>Strength (pounds) (3)</b>
Wood	2x4/1x6	42	2x4/8	200
Pipe	1-1/2 nominal OD	42	1-1/2 nom./8	200
Steel	2x2x3/8 angle	42	2x2x3/8 angle/ 8	200 or equiv. bend. strength
Wire rope	3/8 diameter(4)	42	equivalent to one of above	200
Other equivalent	equivalent to one of above	42	equivalent to one of above	200

1. Acceptable heights range from 39-45 inches (42 ± 3). Mid-rail height should be about half the height of top rail.
2. Spacing is horizontal distance measured center post to center post.
3. Railing must have minimum deflection in any direction of 200 pounds. Force is applied. Minimum deflection is not defined although 3 inches of deflection for wire rope after force is applied is a guideline. Strength criteria also applies to all structural members of system, including post anchorages.
4. There is no OSHA national office guidance at this time for size of wire rope guardrails. Three-eighths of an inch is a recommended size, however, any wire rope size ? inch or larger (as per NPRM for Subpart M) would be acceptable.

*Note: Lumber sizes listed above can be nominal size.*

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