

# Ladders

## Risk Control from Liberty Mutual Insurance



Ladders are standard equipment on most construction sites. Nearly every construction worker uses a ladder at some point or another, and many use them every day. Unfortunately, along with such frequent use comes occasional misuse — and misuse of ladders can cause serious accidents.

Incident prevention is really a matter of good decision making. This reference presents information that can help construction supervisors train or remind workers to make the right decisions when using ladders.

### Highlights:

- Unfortunately, along with such frequent use comes occasional misuse — and misuse of ladders can cause serious accidents
- Incident causes and controls
- General ladder safety
- Spotlight on research: ideal ladder angle to prevent slipping

### Incident Causes and Controls

Ladder-related incidents occur for a variety of reasons, the most common of which are listed here:

1. Ladder slipped
2. Carrying material on ladder
3. Slipped on rung
4. Struck by materials
5. Handling ladder
6. Ladder broke
7. Standing on top
8. Reaching too far
9. Electric shock

Guidelines for controlling these ladder hazards are discussed below.

#### Cause #1: Ladder Slipped

Incidents in which the “ladder slipped” occur more than four times as often as any other type of ladder incident. Therefore, ladder safety training should place special emphasis on controlling the hazards that can lead to ladder slippage.

Supervisors need to teach and enforce the following practices:

- On solid, level surfaces such as concrete floors, use ladders with nonslip feet. (See Figure 1.)
- On solid wood decks and landings, nail down a cleat to keep the base of the ladder from sliding. (See Figure 2.)
- Tie off all ladders, but particularly those being used on slippery surfaces (e.g., metal sheet or plate decking; oil, grease, ice, or water on the surface), or when the support is soft or flexible (e.g., earth, planking, plywood). This can be done by securing the ladder near the top with rope or wire ties. (See Figure 2.)

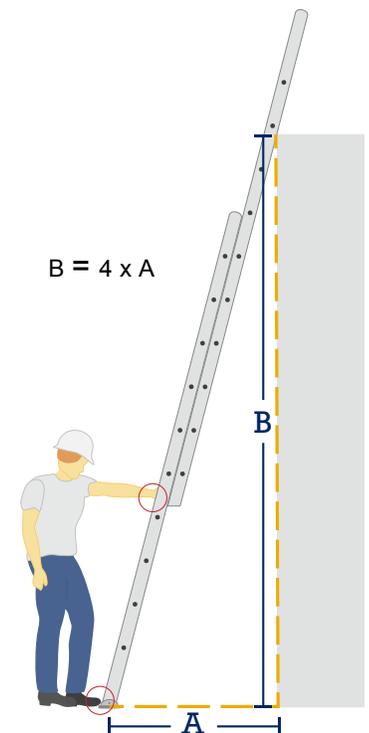


Figure 1.



## Spotlight on Research

A Liberty Mutual study investigated the coefficient of friction at the base of a straight ladder needed to prevent slipping. The study evaluated the effects of inclined angle, climbing speed, ladder type, contact at the top, and the user's weight.

### Design Overview

Seventeen subjects classified into three groups by body weight (light, intermediate, and heavy) performed ladder-climbing tasks under 16 different climbing conditions. For each condition, the subjects repeated the climbing tasks five times. For each trial, participants were required to climb the ladder a total of 10 steps and then descend back to the floor. A force plate was used to measure the normal and tangential ground reaction forces at the bottom of the ladder.

### Summary of Findings

- Inclined angle and climbing speed were the most critical factors affecting the coefficient of friction requirement at the bottom of the ladder.
- The required friction almost doubled when the ladder's inclined angle was flattened to 65°. There was an increase in the required friction as subjects increased their climbing speed from 55 to 75 steps per minute.
- The weight of the user affects the required friction; however, not to the same degree as the inclined angle or climbing speed.

- Ask a helper to hold the ladder on short-term jobs where the ladder base is in the traffic flow. Make sure the helper remains there until the job is completed. Also, redirect traffic.
- Set the ladder at the angle as shown in Figure 1. Ladders placed at low angles are more likely to slip. (See Spotlight on Research, page 3.)

### Cause #2: Carrying Material

Climbing safely up or down a ladder requires both hands. Hand-carrying tools or materials on a ladder can cause you to lose your balance and fall, or drop material on others. Tossing material down from a ladder is also hazardous. Smaller tools can be carried on a tool belt. For larger items, use a hand line to raise or lower tools and materials once you've reached the work position.

### Cause #3: Slipped on Rung

Any number of factors can impair footing on a ladder rung — grease, mud, snow, ice, water, loose handholds, hurrying, sudden use of force.

Anticipate and eliminate these risks before an accident happens. Descend slowly and carefully to prevent slipping on, or missing a rung.

### Cause #4: Struck by Materials

Identify all hazards that could cause workers to be struck or knocked off a ladder. Examples include material being hoisted in the work area, or sudden movement of the material they are working on. Preplanning job assignments and good communication with equipment operators will help reduce the risk of being struck.

### Cause #5: Handling Ladder

One of every 12 severe ladder injuries happens when an individual is lifting or placing the ladder. Instruct and encourage workers to get assistance when needed. Taking down a ladder presents the same handling hazards as erecting it.

### Cause #6: Ladder Broke

Purchase ladders that meet American National Standards Institute specifications (ANSI A14.1, A14.2, and A14.5). A program of regular inspection, maintenance, and replacement will help keep ladders in safe condition. Ensure ladders are inspected at the shop before being shipped to the job. At the beginning of each shift, have a competent person inspect for rot, knots, splits, or cracks in wooden ladders; and for bent, crimped, and damaged rails and rungs on metal and fiberglass ladders. ANSI A14.4 provides job-made ladder requirements.

### Cause #7: Standing on Top

Stepladders are the culprit in most incidents in which the injured party was "standing on top." Most workers know that it is unsafe to stand on the top of a stepladder, but many give in to the temptation anyway, often suffering serious falls. The same goes for straight ladders — do not use the top two rungs of a straight ladder. Remind workers of this fall hazard, and correct them every time you observe them standing on top two steps or rungs.

Other stepladder hazards include using the stepladder as a straight ladder; using the stepladder when it is not fully opened with the spreader locked; and using the back side cross bracing as steps.

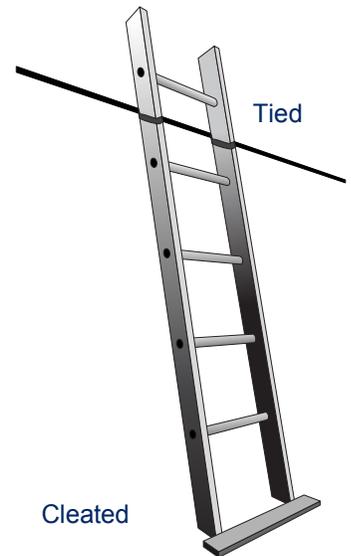


Figure 2.

## Conclusions

According to the study's findings, inclination angle is a critical parameter affecting the friction requirement at the bottom of a straight ladder. The American National Standard ANSI A14.5-2000 recommends a 4:1 ratio (75.5° angle). Most ladder users, however, have no way of measuring the angle of the ladder. Results of other studies showed that when asked to set a ladder at 75.5° without a measurement device, the resulting angle varied from 67.3° to 76.2°. The data also suggest the importance of climbing speed with respect to safety during straight ladder use. It is critical that users not rush when climbing a ladder.

Practical guidelines and training are needed to help reduce the number of fall-related injuries from straight ladders.

## Cause #8: Reaching Too Far

Instruct workers to always follow the Belly Button Rule, which is to keep the belly button (or belt buckle, if you prefer) between the ladder's side rails at all times. It may take a bit more time, but encourage them to climb down and move the ladder to a new location. Reaching too far causes falls — and one fall takes up a lot more time than moving the ladder.

## Cause #9: Electric Shock

Before anyone raises a ladder, examine the work area for electrical exposures. Ask yourself the right questions: Is that overhead wire energized? Will we be too close? Is it possible that a conductive material might hit the ladder? If it is necessary to work near an electrical hazard, have an electrician move or de-energize the electrical conductor (hazard). Workers, other than electrical workers, should keep ladders at least 10 feet (2.734 meters) away from electrical lines. Also be sure that any electrical tools to be used on the ladder are in good condition. Even a minor shock can cause a serious fall.

## General Ladder Safety

Supervisors can use these safety rules as reminders for the workers who use ladders:

- Choose a ladder length that will allow you to work without excessive stretching.
- Check for damaged rungs or side rails, and for loose, broken, or bent hardware. If you think the ladder may be defective, stay off it, and check with your supervisor. Defective ladders should be taken out of service.
- Follow the manufacturer's instructions for extension ladders and maintain an overlap of at least three feet (.914 meter) where the sections are joined.
- If the rungs are wet or slippery, clean them before you climb.
- When setting up, adjust the ladder to the proper slope of 75.5° (4:1). Using the ladder's label as a guide for measuring; set the feet one-quarter of the working length away from the wall (see Figure 1 on page 1).
- Place the ladder base on a firm footing, parallel with the wall.
- Protect the base from traffic. If you must place a ladder in front of a doorway, make sure the door is locked or guarded.
- If you intend to step off the ladder at a higher level, the top of the ladder should extend at least 36 to 42 inches (91 to 1.1 meter) above that level and be secured.
- Open stepladders fully and lock the spreader before using them.
- Keep the areas at the top and bottom of the ladder clear to avoid tripping hazards.
- Place ladders strategically around the jobsite to provide necessary access without the need to carry them long distances.

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