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GENERAL SAFETY

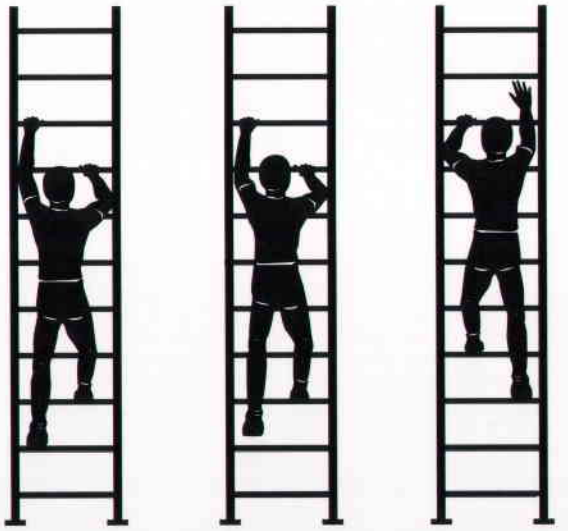
How To Climb An Unsafe Ladder

By Ralph Barnett*

Weaknesses in a ladder structure are not always self revealing. Furthermore, a momentary loss of foot or hand control or even a patch of ice or grease may compromise a climber's safety. The proposed climbing strategy optimizes the safety profile. On the other hand, climbers must continue to follow the "classical ladder rules" dealing with ladder angle, overreaching, etc.

Safe Climbing Method

1. Grasp rungs not siderails
2. Only one appendage per rung
3. Move only one appendage at a time



STAGING	FOOT TRANSITION	HAND TRANSITION
Contact: Two Hands, Two Feet	Contact: Two Hands, One Foot	Contact: One Hand, Two Feet

Figure 1 - Ascension

Power Grip vs Friction Grip

Grasping a rung provides an interference or power grip; holding a siderail develops a frictional grip around rail cross sections that are usually grip unfriendly. The superiority of rung climbing is explored by Barnett and Poczynok [Ref. 1].

Three-Point Suspension

The proposed climbing method, under normal circumstances, always provides three-point or four-point contact for the stability of the climber. The three-point suspension is almost universally recommended [Refs. 2 through 15].

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Load Sharing

The "safe climbing method" always distributes the climber's weight among three or four rungs which minimizes rung loading. Any method that allows, say, two feet to simultaneously perch on a single rung will always lead to a two-rung support during hand transition where one hand becomes free. The same is true for two hands on one rung during foot transition.

Redundancy

By far, the most severe rung loading is transferred through the legs. During *staging*, the proposed climbing strategy provides three-rung support and three-point suspension if rung fracture or foot slip occurs at either foot loaded rung. During *foot transition*, fracture or slipping under the supporting foot causes two hand held rungs to completely resist the climber's weight. If rung fracture or foot slip occurs under either leg during *hand transition*, the climber's weight is equilibrated by a single hand and a single foot.

During a climbing scheme where a rung supporting both feet collapses, the climber's weight is transferred to one or two hand held rungs; one if both climber's hands were on one rung, and two if the climber's hands were on separate rungs. When both hands grasp a single rung and a rung collapses under one foot, the climber's weight is again transferred to two rungs; if the rung being grasped fails, falling is inevitable. Again, when using the proposed climbing strategy failure at a foot loaded rung mobilizes two or three rungs to support the climber.

Siderail Stresses

The proposed climbing method introduces loads into the siderails through the rungs at four locations; the climber's weight is transferred at only two or three locations using conventional climbing scenarios. At each rung the force enters the siderail as a traverse or bending component and as an axial or longitudinal component. The traverse components produce bending stresses whose magnitudes are lowered by spreading out the climber's weight among four rungs. This spreading of the load also increases the buckling resistance of siderails which in turn reduces the bending stresses even more [Ref. 16].

References

1. Barnett, Ralph L. and Peter J. Poczynok. "Ladder Rung vs. Siderail Hand Grip Strategies," *Triodyne Safety Brief* v. 16 #4 (April 2000).
2. Canadian Centre for Occupational Health and Safety. *Important Safety Tips on Using Portable Ladders.* http://www.ccohs.ca/headlines/text31.html (March 1, 2000).
3. *Bustin Truck and Trailer Safety Products.* Bustin Industrial Products, Inc., East Stroudsberg, Pennsylvania. 1994. p. 9.
4. Labour Manitoba, Workplace Safety and Health Division. "Portable Ladder Safety," *Work Safe! Bulletin No.177* http://www.gov.mb.ca/labour/safety/publicat/bulletin/bltn177.html (March 1, 2000).
5. Elsberry, Richard R. "The Ups and Downs of Portable Ladder Safety," *Electrical Apparatus* v. 53 #1 (January 2000): 48-49. *File 15: ABI/INFORM. DIALOG.* (February 29, 2000).
6. Binsacca, Rich. "Ladder to Success," *Builder* v. 21 #14 (November 1998): 141. *File 15:ABI/INFORM. DIALOG.* (February 29, 2000).
7. Miller, Barrett. "Safe Ladder Management," *Professional Safety* v. 42 #11 (November 1997): 30-32. *File 15: ABI/INFORM. DIALOG.* (February 29, 2000).
8. Office of Occupational Health and Safety. *Ladders & Step Ladder Safety.* University of Victoria, Victoria, British Columbia, Canada. http://web.uvic.ca/ohs/ladder.html (December 15, 1999).
9. *Workplace Safety Program for Jay Bee Painting.* Jay Bee Painting, Ocala, Florida. http://www.atlantic.net/~titan/jaybee/safety.html (December 15, 1999).
10. *Ladders.* Construction Safety Association of Ontario. Toronto, Ontario, Canada. Revised Edition, April 1984.
11. *Ladder Safety.* National Safety Council. Itasca, Illinois.
12. Miller, Barrett. "Safe Ladder Management," *Professional Safety* v. 42 #11 (November 1997): 30-32.
13. Hammer, Wilfried and Udo Schmalz. "Human Behaviour When Climbing Ladders with Varying Inclinations," *Safety Science* v. 15 (1992): 21-38.
14. *Rincon Industries Ladder Safety Guidelines.* Rincon Industries, San Diego, California. http://www.rinconind.com/guide.html (March 1, 2000).
15. Canada NewsWire. "Safety Alert - Don't Let Safety Get Rusty This Winter." November 22, 1999. *Dow Jones Interactive Publications Library.* (December 14, 1999).
16. Timoshenko, S., *Theory of Elastic Stability.* New York, McGraw-Hill, 1936. Chapters I and II.