

This PDF includes a chapter from the following book:

# **The Staircase**

## **Studies of Hazards, Falls, and Safer Design**

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### **OA Funding Provided By:**

National Endowment for the Humanities/Andrew W. Mellon Foundation Humanities Open Book Program.

The title-level DOI for this work is:

[doi:10.7551/mitpress/6434.001.0001](https://doi.org/10.7551/mitpress/6434.001.0001)

## NOTES

### 1 THE CHARACTERISTICS OF STAIR FALLS AND INJURIES

1. This does not include falls in or from transport vehicles or while boarding or alighting from them.
2. Archea et al. (1979) provide a comprehensive listing of accident causes discussed in the literature from 1960 to 1979. Further evidence is provided in Templer et al. (1978, 1985).
3. A study entitled "Fundamental Studies in Reducing the Severity of Injuries from Stairway Falls" is underway at the Georgia Institute of Technology with funding from the National Science Foundation. John Templer, Satya Hanagud, and Toby Boulet are the principal investigators. The study will develop a computer model of stair falls.

### 2 RISER AND TREAD GEOMETRY FOR COMFORT AND SAFETY

1. The other linear measure in use in France at the time—the Roman foot—seems to have been used mainly in the cloth industry (Skinner 1967).
2. Olmsted (1911) names some of the authors but without references and not always correctly.
3. Equations 2.6 and 2.7 have appeared in many editions of *Time Saver Standards* (see Callender 1982)—with an error in equation 2.6 that has been incorrectly copied from Freeze's original formula. *Time Saver Standards'* version of 2.6 is 
$$R = 9 - \sqrt{\frac{1}{2}(G-8)(G-2)}.$$

4. Olmsted (1911). When this paper was published, the more famous Frederick Law Olmsted, Sr., was dead; it is possible that the paper is by the younger Olmsted.

5. The equation for men is as follows:

$$\begin{aligned} \log_e Y &= 0.0417993918 V \cos \theta \\ &+ 0.0005876207 WR \sin \theta \\ &- 0.0009464963 WT \sin \theta \\ &- 0.0002390824 (V \cos \theta)^2 \\ &+ 0.0003753539 VT \cos \theta \\ &+ 0.4385368671 \theta^2 - 2.142576059 \end{aligned}$$

The equation for women is:

$$\begin{aligned} \log_e Y &= 0.0253402476 V \cos \theta \\ &- 0.0010823549 WT \sin \theta \\ &+ 0.003480929R^2 - 0.0007577114T^2 \\ &- 1.485224153 \end{aligned}$$

And the equation for all the subjects is:

$$\begin{aligned} \log_e Y &= 0.0453353942 V \cos \theta \\ &- 0.2907272046 WV \sin \theta \cos \theta \\ &- 0.0002056409 (V \cos \theta)^2 \\ &- 0.0011300552 WT \sin \theta \\ &+ 0.0012330934 WR \sin \theta - 2.049299478 \end{aligned}$$

Where  $Y$  = kilocalories per minute per kilogram  
 $V$  = velocity of climb (vertical) (feet per minute)  
 $\theta$  = angle of stair to horizontal (radians)  
 $R$  = riser height (inches)  
 $W$  = weight (kilograms)  
 $T$  = tread (inches)