Preventing Swing Falls in Bridge Work

American Road & Transportation Builders Association

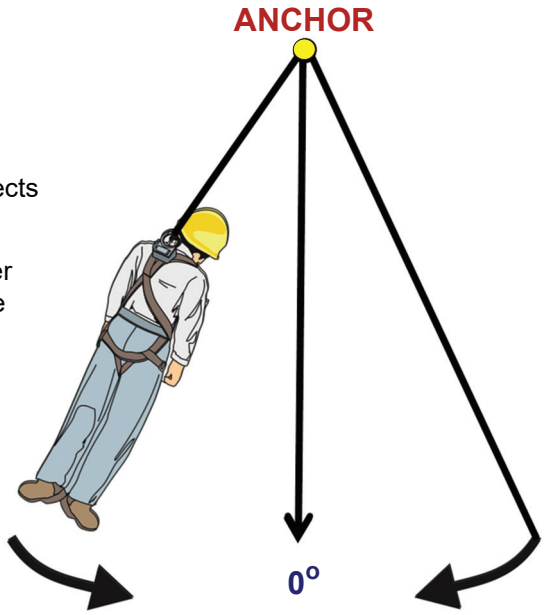
What Is a Swing Fall?

If the anchor in a personal fall arrest system (PFAS) is not directly above a worker's head at 0° at all times, then any fall will include a horizontal direction. The horizontal direction makes the fall a 'swing fall' or pendulum fall.

The greater the angle from the anchor to the worker:

- the greater the arc of the swing fall
- the faster the velocity or speed of the swing fall
- the longer the vertical fall (free fall)

As the arc and velocity increase, so does the likelihood of impact with objects in the path of the swing fall.

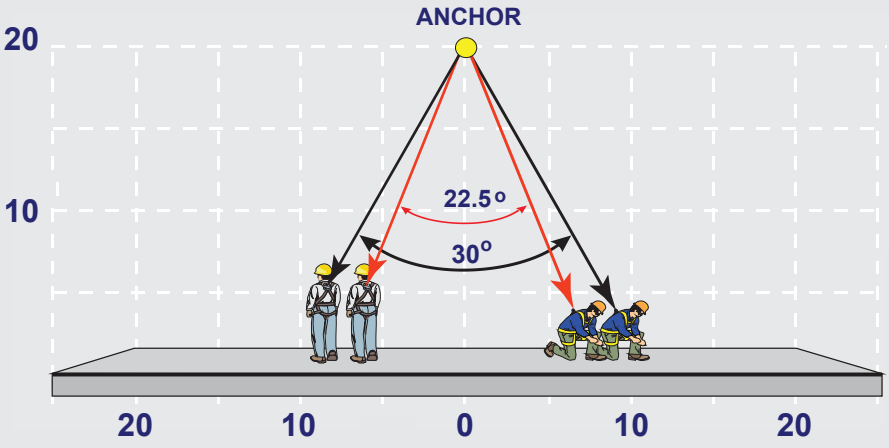


The maximum arc of a swing fall is typically defined by degrees off center from the anchor, added to both sides of the center line. In practice, the arc of the fall will be somewhat less, because the energy of the horizontal movement, which is greatest when the fall begins, will diminish as the swing fall crosses the point of the overhead anchor (0°).

A swing fall can generate a lot of horizontal impact force. A worker in a swing fall can easily reach 20+ miles per hour in the horizontal direction. (A method for calculating swing fall speed appears on the reverse of this sheet.) A face, shoulder, arm, or back smashing into equipment or a structural member will cause serious harm or death for a worker.

Set Maximum Work Ranges

Swing falls can be minimized by working as directly below the anchor as possible (0° line). To reduce the risk of a swing fall, a company's fall plan should set up a maximum work range from the anchor point to be calculated and enforced by the competent person. Many PFAS manufacturers recommend no more than 30° and others recommend 22.5° or less.



In the diagram on the left, the 0° line is directly below the anchor. The anchor is 20 feet above the working surface.

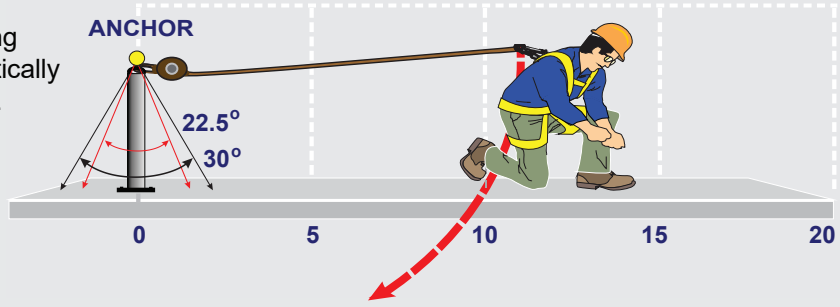
The 30° lines define a work range of about 8 feet out from the anchor line (0°). The 22.5° lines define a range of about 6 feet from 0°.

For an anchor lower than 20 feet, the work range shrinks proportionately.

A worker anchored at or near the working surface is at increased risk of a swing fall.

If the anchor is less than 5 feet above the working surface (right), then the safe work range is drastically reduced to 2.5 feet out from the anchor line (0°).

Workers often exceed the maximum safe work range and this increases swing fall momentum and free fall distance.



Source: FOF.

How To Calculate Free Fall Distance and Speed in a Swing Fall

If an employee works more than 30° from the anchor, in a swing fall the line will be much longer than if the worker fell directly at 0°. The farther from 0°, the farther the free fall and the faster the falling worker moves.

- Measure the length of the line from the anchor to the D-ring at 0°. This represents the length of the line if no swing fall condition existed. Call it **B**.*
- Measure the length of the line from the anchor to the D-ring at the farthest work range along the edge. Call it **C**.
- Find the difference between **B** and **C**. Call this **L**. ***L is the vertical distance of the free fall.***
- To find the speed, multiply **L** x 32 x 2 x 2. This is the effect of gravity on a falling object — 32 feet per second per second. Then convert feet per second to miles per hour.

EXAMPLE AT RIGHT:

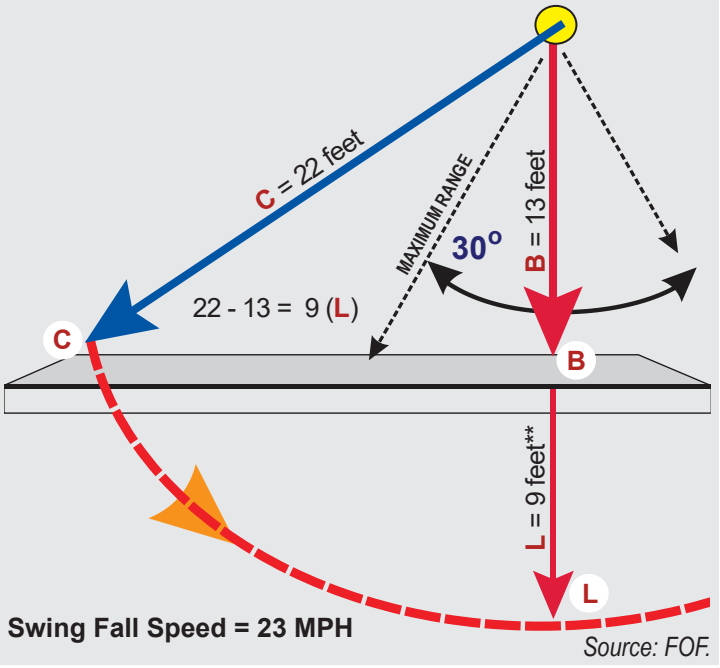
B (anchor to D-ring at 0°) = 13 feet
C (anchor to maximum) = 22 feet

C		B		L
22	-	13	=	9

Horizontal Speed: **L** 9 x (**Effect of Gravity** 32 x 2 x 2) = $\sqrt{1152}$ = **FPS** 34 ft per sec

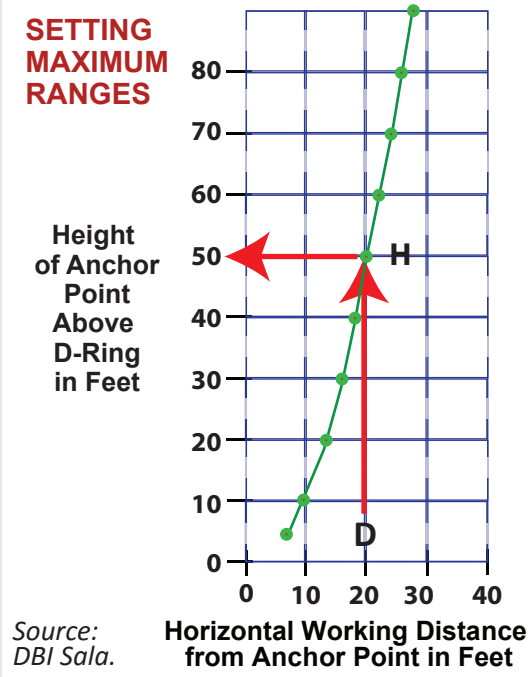
Miles Per Hour: (**FPS** 34 x **Sec to Hrs** 3600) / **Mile** 5280 = **Speed** 23 MPH

* If you only know **B**, you can calculate **C**:
Measure the maximum distance on the edge from the 0° position at which the worker will work (A). Use $A^2 + B^2 = C^2$ to find the maximum length of line in the event of a swing fall. $C = \sqrt{A^2 + B^2}$



Swing Fall Speed = 23 MPH

Source: FOF.



Source: DBI Sala.

How To Set Maximum Work Ranges

The chart on the left is an easy tool for finding the maximum work range for a given anchor height. These examples show how the chart works:

1. For work 20 feet from the overhead anchor point (0°), how high must the anchor point be placed above the D-Ring?
   - Look across the chart horizontally to the 20-foot mark. This is the desired horizontal working distance from anchor point (D).
   - Follow the vertical up to intersect the green line. Then follow the green line back to the height of anchor point above D-Ring at left (H). The anchor point would have to be at 50 feet above the D-Ring.
2. If the only anchor point available is 30 feet above, how much horizontal working distance from the anchor point will the worker have?
   - Find the height of anchor point above D-Ring (H) on the vertical axis. Follow it across to intersect the green line.
   - Now follow down to the axis for the horizontal working distance from the anchor point (D): about 15 feet.

ARTBA Work Zone Safety Consortium

American Road and Transportation Builders Association ■ U.S. Department of Transportation Federal Highway Administration
National Asphalt Pavement Association ■ Texas A&M Transportation Institute
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Community College Consortium For Health and Safety Training ■ American Association of State Highway and Transportation Officials

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