

SoRE Bicycle Stem Horizontal Distance (HD) Calculation

by David Hartley

On a bicycle, the horizontal distance (HD) from the center of the steering tube top cap bolt (or stem fixing bolt on a “quill” stem) to the center line of the horizontal tube of the handlebar can be calculated by the following equation:

$$\mathbf{HD = SL \times \cos(HTA^\circ - SA^\circ)}$$

where

SL = stem length, HTA = head tube angle, and SA = stem angle

The five most common stem angle offerings for the average road bike (with a 73° head tube angle*) give us the following horizontal distance equivalency table:

Stem Angle (SA)	cos(HTA°-SA°)	Horizontal Distance (HD)
73° (-17°)	1.000	SL x 1.000
84° (-6°)	0.982	SL x 0.982
90° (0°)	0.956	SL x 0.956
96° (+6°)	0.921	SL x 0.921
107° (+17°)	0.829	SL x 0.829

(e.g. A 120mm (±17°) stem attached at an angle of 73° to the steerer tube is over 20.5mm “longer” horizontally than a 120mm stem attached at 107° to the steerer tube.)

These figures allow a cyclist to fine-tune the fit of the bicycle in smaller increments than those standardly offered by the stem manufacturers, as well as determining how the distance from the saddle tip to the handlebar is affected by “flipping” a threadless stem.

Note that the distance from the saddle tip to the handlebar is also affected by raising or lowering the quill or threadless stem. The change in horizontal distance (ΔHD) can be calculated by the following equation:

$$\Delta HD = \cos HTA^\circ \times \Delta SP \text{ (sign convention: “+” for lowering and “-” for raising)}$$

where

HTA = head tube angle, and ΔSP = change in stem position (distance along the axis of the steerer tube)

$$> \text{ for a head tube angle of } 73^\circ \text{ -- } \Delta HD = 0.2924 \times \Delta SP$$

(e.g. Raising a stem 5mm along a steerer tube at an angle of 73° to the ground, gives us a ΔHD of -1.46 mm – equating to a shortening of the distance from the tip of the saddle to the handlebar by 1.46 mm.)

WARNING: Most threadless fork manufacturers suggest limiting spacers used to raise the stem to 25 mm or less. See markings on quill type stems for an indication of minimum required insertion into the steerer tube.

These calculations are intended as a fine-tuning guide for experienced cyclists who are close to determining their optimum position on their bike. There are many other variables that require attention including: frame size and geometry, saddle height and position, and crank length. If you are unsure about whether or not your bicycle actually fits you correctly, or you are considering purchasing a new bike, please visit a local bike shop that offers a bicycle “fit kit”. A fit kit is an adjustable bike that can help you determine your most comfortable riding position – giving you a good starting point before you move on to fine-tuning your “ride”.

If you have questions, corrections, suggestions, or other comments -- please e-mail: Tequila Dave

*See your frame manufacturer’s dimensional data for your actual HTA.