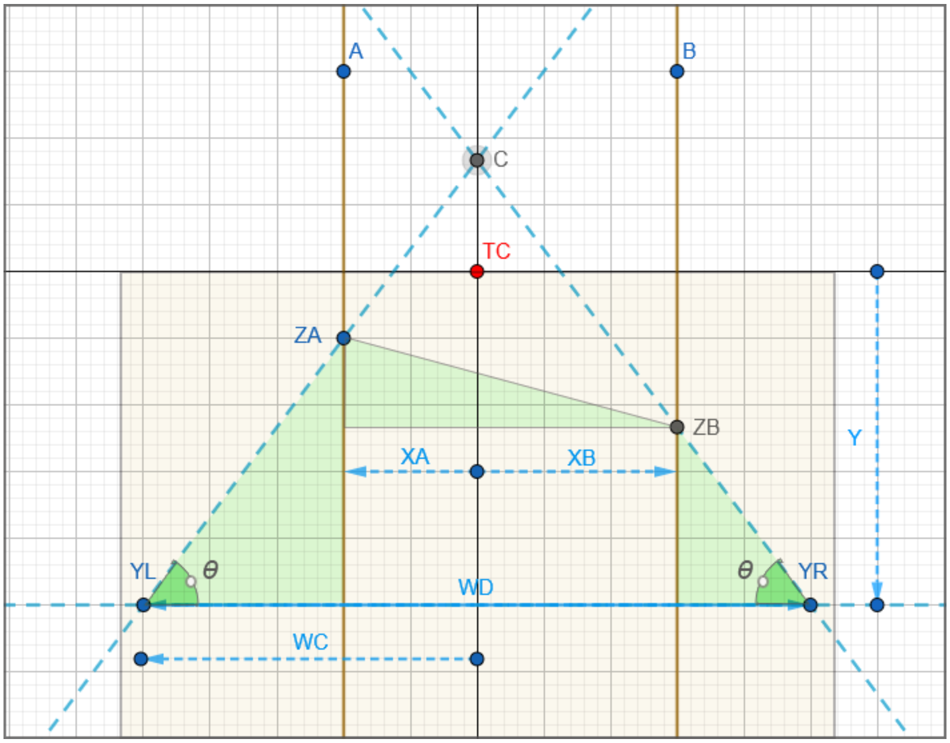

Hanging an Item on Two Off-Center Studs

Craig H. Collins | chcollins.com | September 16, 2021

In the figure above, the item to be hung is represented by the shaded rectangle. We know the dimensions of the item, the location of the studs, and the desired position of the item on the wall. We also know the desired location of the wall hook at ZA, the distance between the wire attachment points W_D, and the desired wire angle θ. We want to spot the lower wall hook (ZB) and find the distance Y from the top of the frame to the wire attachment points YL and YR. From this we can calculate the wire length S.

We first mark the desired top-center of the item (TC). We then find the nearest studs A and B, where A is the closer of the two. X_A and X_B are the distances from the centerline of the item to the center of the respective studs.

We now mark point ZA on Stud A at distance Z_A from the top of the item, and draw a line of angle θ through point ZA. We mark point C where this line crosses the centerline and mark point YL where the line is distance $W_C = W_D/2$ from the centerline. We then mark the point YR on the opposite side of the centerline at distance W_C from the center.

Finally, we draw a line from point C to point YR. Where this line intersects the centerline of Stud B is point ZB, the location of the other hook.

In algebraic terms,

$$\tan\theta = (Y - Z_A)/(W_C - X_A) \text{ or} \tag{1}$$

$$Y = Z_A + (W_C - X_A)\tan\theta \tag{2}$$

At this point, we need to verify that Y is a reasonable distance from the top of the item, i.e., no more than one-third the item height, otherwise the forward tilt could be excessive. If Y/H is greater than 1/3, the wire angle θ should be reduced. This implies

$$Y_{max} = H/3 \tag{3}$$

$$\tan\theta_{max} = (H/3 - Z_A)/(W_C - X_A) \tag{4}$$

Assuming $Y <= Y_{max}$ and knowing the triangles at YA and YB are similar,

$$Z_A + (W_C - X_A)\tan\theta = Z_B + (W_C - X_B)\tan\theta \tag{5}$$

$$Z_B = Z_A + (X_B - X_A)\tan\theta \tag{6}$$

Lastly, we find wire length S by summing the hypoteneuses of the three triangles:

$$\begin{aligned} S = &\sqrt{(W_C - X_A)^2 + (Y - Z_A)^2} \\ &+\sqrt{(X_A + X_B)^2 + (Z_B - Z_A)^2} \\ &+\sqrt{(W_C - X_B)^2 + (Y - Z_B)^2} \\ &-2D + 2E \end{aligned} \tag{7}$$

where D is the length of a D-ring and E is the excess wire on each end.