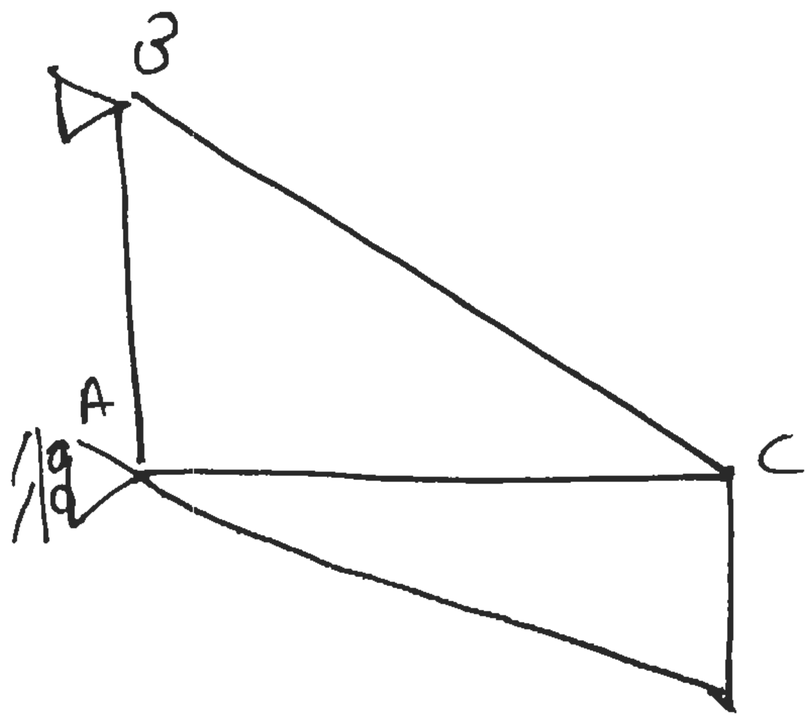
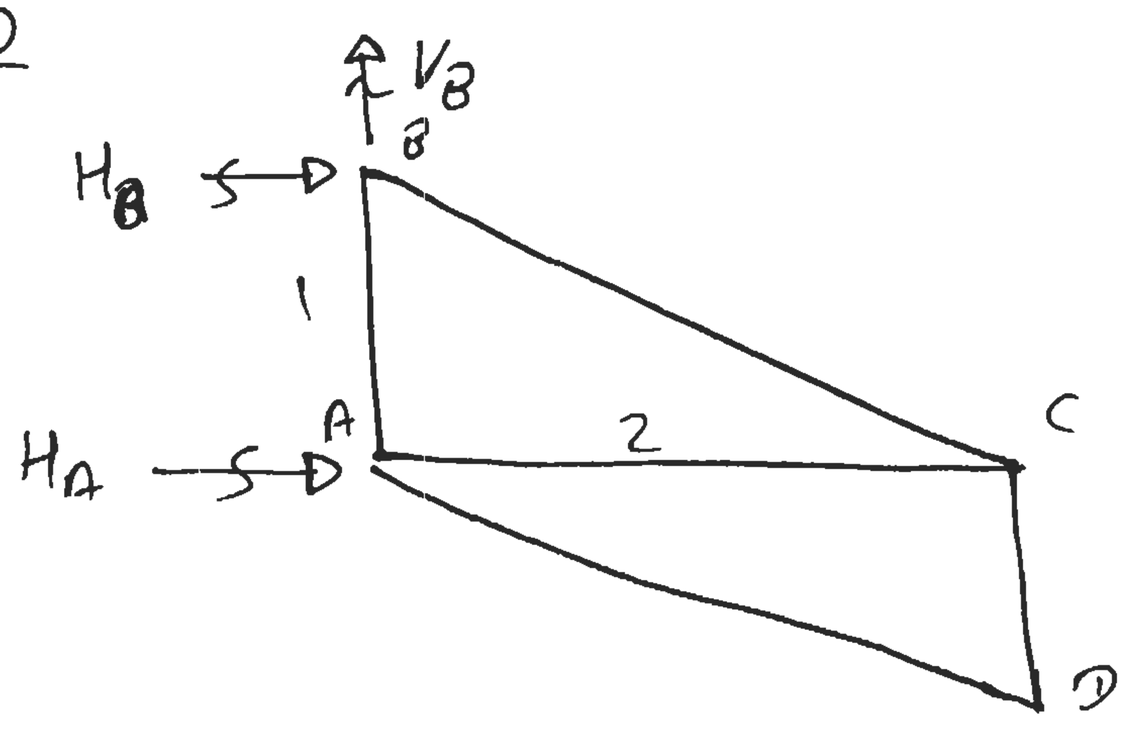
M10 Use superposition (or set up as a set of unknowns)



R_D - effect of roller.

FBD



R_D

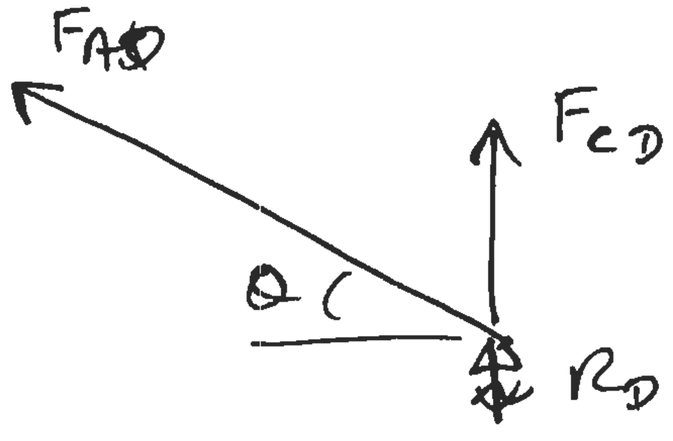
$\sum F_y \uparrow = 0$: $V_B + R_D = 0$ ① $V_B = -R_D$

$\sum \vec{F_x} = 0$: $H_A + H_B = 0$ ②

$\sum (\circlearrowright M_B = 0$: $H_A \cdot 1 + R_D \cdot 2 = 0$ $H_A = -2R_D$

$H_B = +2R_D$.

Bar forces: Method of joints



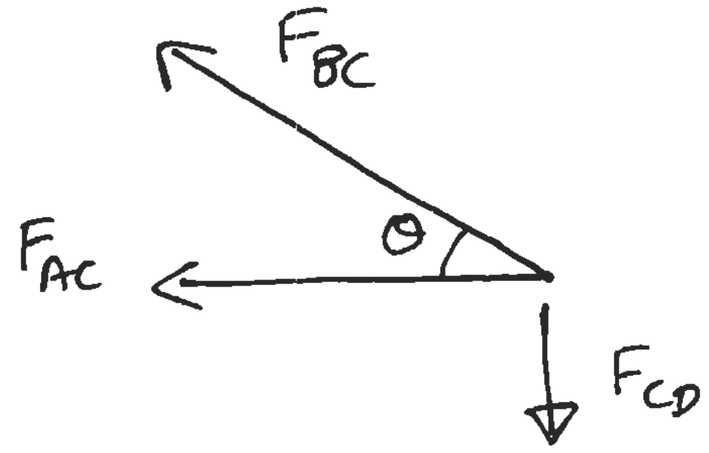
$$\cos\theta = \frac{2}{\sqrt{5}}$$

$$\sin\theta = \frac{1}{\sqrt{5}}$$

$\sum \vec{F_x} = 0$: $F_{AD}\cos\theta = 0$ $\Rightarrow F_{AD} = 0$

$\sum F_y \uparrow = 0$ $F_{AD}\sin\theta + F_{CD} + R_D = 0$

$$F_{CD} = -R_D$$

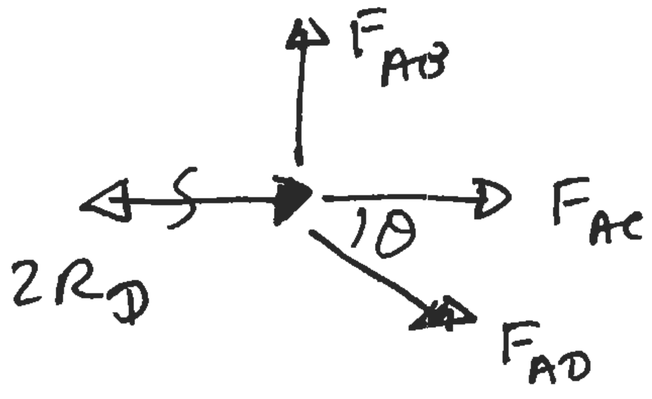


$\sum F_y \uparrow = 0$: $F_{BC}\sin\theta - F_{CD} = 0$

$$F_{BC} = \underline{-R_D\sqrt{5}}$$

$\sum \vec{F_x} = 0$: $-F_{AC} - F_{BC}\cos\theta = 0$

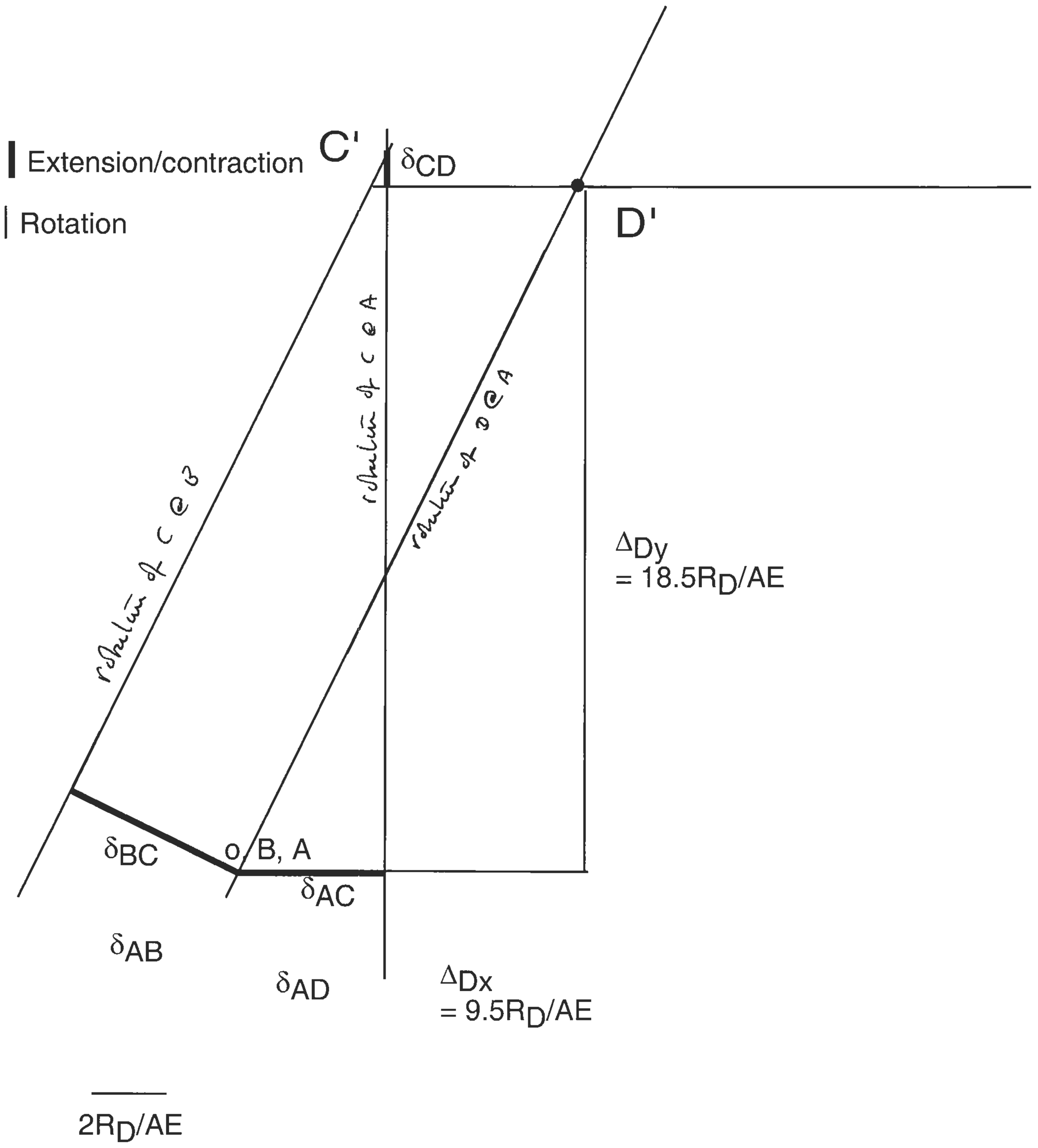
$F_{AC} = R_D\sqrt{5}\cdot\frac{2}{\sqrt{5}} = 2R_D$ ⟸



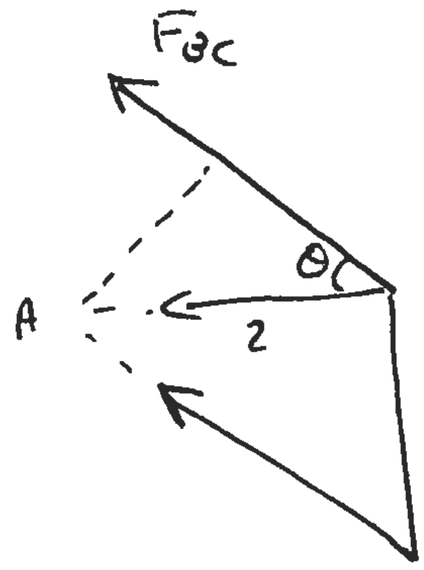
$\sum F_y \uparrow = 0$ $F_{AB} - F_{AD}\sin\theta = 0$

$F_{AB} - 0 = 0$

$F_{AB} = 0$


Extension/contraction
Rotation
C'
δ_{CD}
D'
rotation of C @ B
rotation of C @ A
rotation of D @ A
δ_{BC}
B, A
δ_{AC}
δ_{AB}
δ_{AD}
Δ_{Dy}
$= 18.5R_D/AE$
Δ_{Dx}
$= 9.5R_D/AE$
$2R_D/AE$

check M o S



$\sin\theta = \frac{1}{\sqrt{5}}$

$\cos\theta = \frac{2}{\sqrt{5}}$

$\sum M_A = 0$

$R_D \cdot 2 + F_{BC} 2\sin\theta = 0$

$F_{BC} = -\frac{1}{2} R_D \frac{\sqrt{5}}{1} = -\sqrt{5} R_D$ ✓ $\frac{9}{4} R_D$

check

Bar	Length	Force / R_D	$\delta / R_D / AE$
AB	1	0	0
AC	2	2	4
BC	$\sqrt{5}$	$-\sqrt{5}$	-5
AD	$\sqrt{5}$	0	0
CD	1	-1	-1

Draw displacement diagram

D displaces upward $\Delta D_y = \frac{18.5 R_D}{AE}$

Since D is on a roller $\delta^{(M9)} + \delta^{(M10)} = 0$

$\frac{92.5 \times 10^3}{AE} + \frac{18.5 R_D}{AE} = 0$ $R_D = -\frac{92.5 \times 10^3}{18.5} = -5\ kN \in$

Horizontal deflection :

$$\Delta D_x^{M9} + \Delta D_x^{M10} = \frac{75\times10^3}{AE} + \frac{(9.5\times-5)\times10^3}{AE} = 786\times10^{-6}$$

$$= 0.79\,mm \Leftarrow$$

Reactions

$$\rightarrow H_B = H_B^{M9} + H_B^{M10} = +10 + 2(-5) = 0 \Leftarrow$$

$$H_A = H_A^{M9} + H_A^{M10} = -20 + \tfrac{2}{3}(-2(-5)) = -10\ KN \Leftarrow$$

$$V_B = V_B^{M9} + V_B^{M10} = 0 - (-5) = +5\ KN \Leftarrow$$