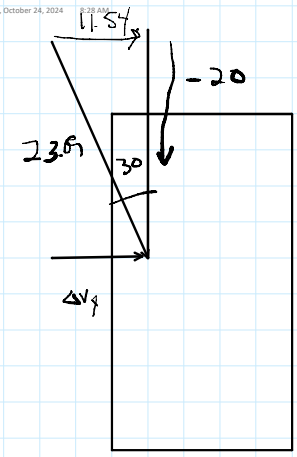
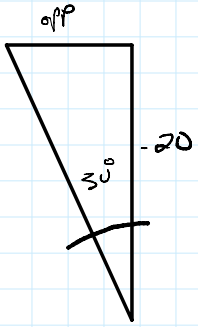
Adjusting for Offset Collisions

Thursday, October 24, 2024 8:28 AM



$\Delta V_x = -20 mph$

$\alpha = 30°$



$\tan\theta = \frac{opp}{adj}$

$\tan^{-1}30 = \frac{opp}{-20}$

$-0.5774 = \frac{\Delta V_y}{-20}$

$\Delta V_y = 11.54$

$\Delta V_\varepsilon = \frac{\Delta V_x}{\cos\alpha}$

$\Delta V_\varepsilon = \frac{-20}{\cos(30)}$

$\Delta V_\varepsilon = 23.09$

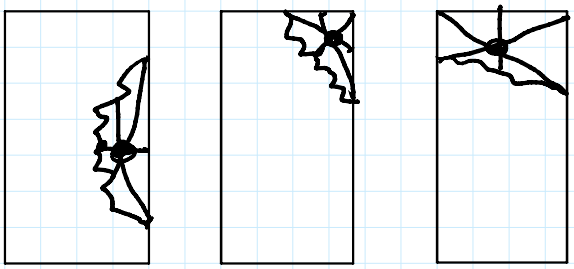
$\Delta V_\varepsilon^2 = \Delta V_x^2 + \Delta V_y^2$

$(23.09)^2 = (-20)^2 + \Delta V_y^2$

$533.15 = 400 + \Delta V_y^2$

$133.15 = \Delta V_y^2$

$11.54 = \Delta V_y$



$Y = 1.03X - 1206$ $r^2 = 0.88$

$r^2 = 0.73$

Steps to calculate EMR

1. Calculate ΔV of other vehicle
2. Calculate I_{yaw} for each vehicle
3. Calculate k^2 for each vehicle
4. Find the lever arm, h. (measure or calculate)
5. Calculate γ (EMR) for each vehicle
6. Calculate $V_{c,\Delta V}$

*Calculate Answers in Red

White Car

$W_W = 4600$ lbs

Red Car

$W_R = 3250$

$\Delta V_W = 5.07$ mph

$I_y = 3532$

$k^2 = 24.72$

$h = 1.0$ (measured)

$\gamma_W = 0.96$

$\Delta V_x = 2.3$ mph

$\Delta V_y = 6.8$ mph

$\Delta V_\Sigma = 7.18$ mph

$I_y = 2141.5$

$k^2 = 21.22$

$h = 7.0$

$\gamma_R = 0.30$

STEP ONE: Calculate ΔV_W

$$\Delta V_W = \Delta V_R \left(\frac{W_R}{W_W}\right)$$

$$\Delta V_W = (7.18)\left[\frac{3250}{4600}\right]$$

$$\Delta V_W = (7.18)(0.7065)$$

$$\Delta V_W = 5.07 \text{ mph}$$

$$\Delta V_\Sigma = \sqrt{\Delta V_x^2 + \Delta V_y^2}$$

$$\Delta V_\Sigma = \sqrt{(2.3)^2 + (6.8)^2}$$

$$\Delta V_\Sigma = \sqrt{5.29 + 46.24}$$

$$\Delta V_\Sigma = \sqrt{51.53}$$

$$\Delta V_\Sigma = 7.18 \text{ mph}$$

STEP TWO: Calculate I_y for each vehicle

White Car

$$I_y = 1.03 W_W - 1206$$

$$I_y = (1.03)(4600) - 1206$$

$$I_y = 4738 - 1206$$

$$I_y = 3532$$

Red Car

$$I_y = 1.03 W_R - 1206$$

$$I_y = (1.03)(3250) - 1206$$

$$I_y = 3347.5 - 1206$$

$$I_y = 2141.5$$

STEP THREE: Calculate k^2

White car

$$k^2 = \frac{I_y (g)}{W}$$

$$k^2 = \frac{(3532)(32.2)}{4600}$$

$$k^2 = \frac{113730.4}{4600}$$

$$k^2 = 24.72$$

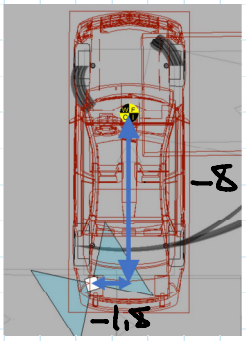
Red Car

$$k^2 = \frac{I_y (g)}{W}$$

$$k^2 = \frac{(2141.5)(32.2)}{3250}$$

$$k^2 = \frac{68956.3}{3250}$$

$$k^2 = 21.22$$



STEP FOUR: Find the Lever Arm

$r_x = -8$ $\quad r_y = -1.8$

STEP FOUR: FIND THE LEVER ARM

$r_x = -8$ $\quad r_y = -1.8$

$\Delta V_y = 6.8$ $\quad \Delta V_x = 2.3$

$\Delta V_\varepsilon = 7.18$

white car

$h = 1.0$ (measured)

Red Car

$$h = \frac{|r_x \Delta V_y - r_y \Delta V_x|}{|\Delta V_\varepsilon|}$$

$$h = \frac{|(-8)(6.8) - (-1.8)(2.3)|}{7.18}$$

$$h = \frac{|-54.4 - (-4.14)|}{7.18}$$

$$h = \frac{|-54.4 + 4.14|}{7.18}$$

$$h = \frac{50.26}{7.18}$$

$$h = 7.0 \text{ ft}$$

STEP FIVE: Calculate EMR for both vehicles

White Car

$$\gamma_w = \frac{k^2}{k^2 + h^2}$$

$$\gamma_w = \frac{24.72}{24.72 + (1)^2}$$

$$\gamma_w = \frac{24.72}{25.72}$$

$$\gamma_w = 0.96$$

Red Car

$$\gamma_R = \frac{k^2}{k^2 + h^2}$$

$$\gamma_R = \frac{21.22}{21.22 + (7)^2}$$

$$\gamma_R = \frac{21.22}{21.42 + 49}$$

$$\gamma_R = \frac{21.22}{70.42}$$

$$\gamma_R = 0.30$$

STEP SIX: Calculate $V_{c,\Delta v}$

$e = 0$

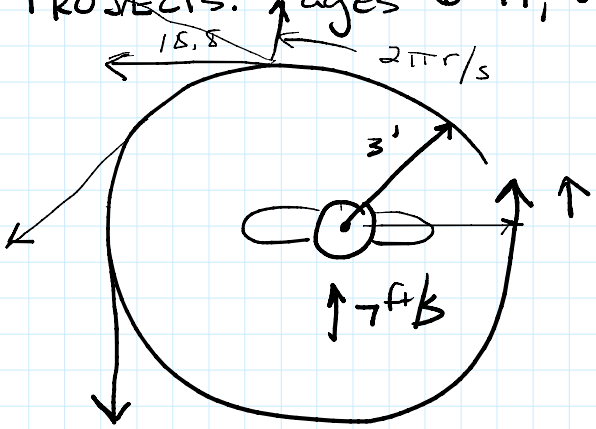
$$V_{c,\Delta v} = \left[\frac{1}{1+e}\right]\left[\frac{|\Delta V_w|}{\gamma_w} + \frac{|\Delta V_R|}{\gamma_R}\right]$$

$$V_{c,\Delta v} = \left[\frac{1}{1+0}\right]\left[\frac{5.07}{0.96} + \frac{7.18}{0.30}\right]$$

$$V_{c,\Delta v} = 5.28 + 23.93$$

$$\boxed{V_{c,\Delta v} = 29.21 \text{mph}}$$

PROJECTS: Pages 6-17, 6-29 NOT 6-90



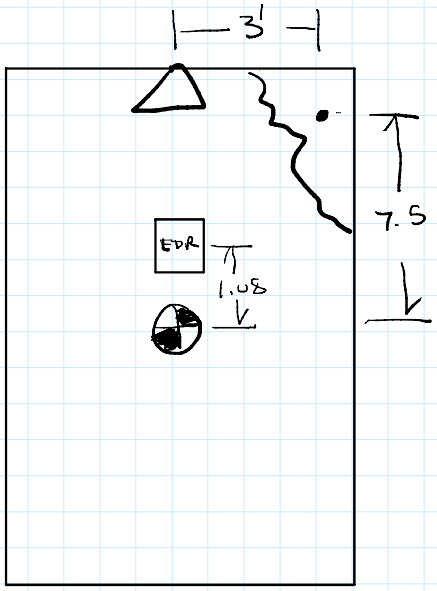
$V = \omega r$

$V = (2\text{ ft}^{\circ}/s)(3\text{ ft})$ units ft/s

$V = 2(3.14)(3)$

$V = 18.8\text{ f/s}$

$18.8 + 7 = 25.8\text{ f/s}$



$\Delta V_2 =$

$W_1 = 4370$

$\Delta V_x^{EDR} = -9.9\text{ mph}$

$\Delta V_y^{EDR} = -6.8\text{ mph}$

$r_x^{EDR} = 1.08'$

$r_x^{cent} = 7.5'$

$r_y^{cent} = 3'$

1. Calculate I_{yaw}

$I_{yaw} = 1.03w - 1206$

$I_{yaw} = 1.03(4370) - 1206$

$I_{yaw} = 4501.1 - 1206$

$I_{yaw} = 3295.1$

2. Calculate k^2

$k^2 = \frac{I_{yg}}{w}$

$k^2 = \frac{(3295.1)(32.2)}{4370}$

$k^2 = \frac{106102.22}{4370}$

$k^2 = 24.28$

$\Delta V_x^{EDR} = -9.9$

$\Delta V_y^{EDR} = -6.8\text{ mph}$

$k^2 = 24.28$

$r_y^{cent} = 3'$

$r_x^{cent} = 7.5'$

$r_x^{EDR} = 1.08'$

3. Calculate ΔV_y^{CG}

$$\Delta V_y^{CG} = \frac{\Delta V_y^{EDR} \cdot k^2 + \Delta V_x^{EDR} \cdot r_y^{cent} \cdot r_x^{EDR}}{k^2 + r_x^{cent} \cdot r_x^{EDR}}$$

$$\Delta V_y^{CG} = \frac{(-6.8)(24.28) + (-9.9)(3)(1.08)}{24.28 + (7.5)(1.08)}$$

$$\Delta V_y^{cb} = \frac{(-6.8)(24.28) + (-9.9)(3)(1.08)}{24.28 + (7.5)(1.08)}$$

$r_x = 7.5'$

$r_x^{EPR} = 1.08'$

$$\Delta V_y^{cb} = \frac{-165.1 + (-32.1)}{24.28 + 8.1}$$

$$\Delta V_y^{cb} = \frac{-197.18}{32.38}$$

$$\Delta V_y^{cb} = -6.09 \text{ mph}$$

4. Calculate ΔV_Σ

$$\Delta V_\Sigma = \sqrt{\Delta V_{xcb}^2 + \Delta V_{ycb}^2}$$

$$\Delta V_\Sigma = \sqrt{(-9.9)^2 + (-6.09)^2}$$

$$\Delta V_\Sigma = \sqrt{98.01 + 37.08}$$

$$\Delta V_\Sigma = \sqrt{135.09}$$

$$\Delta V_\Sigma = 11.62 \text{ mph}$$

5. Calculate h

$$h = \frac{r_x^{cent} \cdot \Delta V_y^{cb} - r_y^{cent} \Delta V_x^{cb}}{\Delta V_\Sigma}$$

$$h = \frac{(7.5)(-6.09) - (3)(-9.9)}{11.62}$$

$$h = \frac{-45.68 + 29.7}{11.62}$$

$$h = \frac{-15.97}{11.62}$$

$$h = -1.37'$$

6. Calculate γ

$$\gamma = \frac{k^2}{k^2 + h^2}$$

$$\gamma = \frac{24.28}{24.28 + (1.37)^2}$$

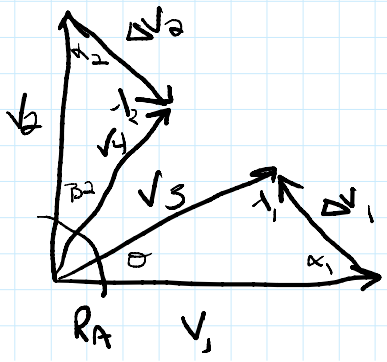
$$\gamma = \frac{24.28}{26.16}$$

$$\gamma = 0.93$$

$\Rightarrow$ Calculate $V_{c,\Delta V} = \left[\frac{1}{1+c}\right]\left[\frac{|\Delta V_1|}{\gamma_1} + \frac{|\Delta V_2|}{\gamma_2}\right]$

Things to study

Triangle Velocity Vectors



EMR - know the steps to calculate EMR & $V_{c,\Delta V}$

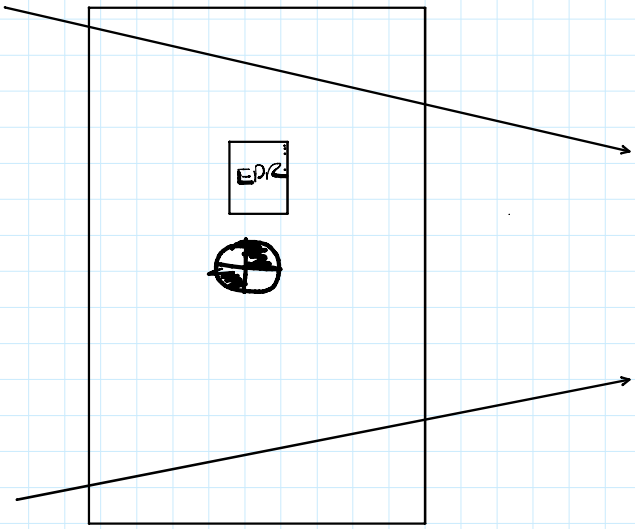
GROUND FORCES

Be able to calculate ground forces

$$\Delta V_{adj} = \frac{fgst}{1.466} \qquad \Delta V_2 = -\Delta V_1 \left(\frac{W_1}{W_2}\right)$$

$$\Delta V_{corr} = \Delta V_1 \pm \Delta V_{adj}$$

Know when to make the magnitude of the ΔV bigger & smaller



Know when EDR will under/over report ΔV @ CG