External Forces

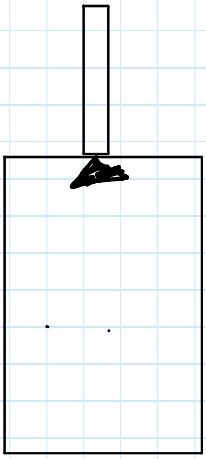
Tuesday, October 23, 2024 9:21 AM

Car with EDR skidding during the crash pulse

REDUCE the magnitude of the EDR-reported delta-V.

$$\Delta v_{adj} = \frac{fg\Delta t}{1.466}$$

$$\Delta v_{cor} = \Delta v_i \pm \Delta v_{adj}$$



$W_C = 4000$ lbs

$\Delta V_{EDR} = -8$ mph

$\Delta t = 150$ ms

$e = 0.1$

$f = 0.8$ g's

$W_{mL} = 800$ lbs

$\Delta V_{mL} =$

$V_{c,\Delta V} =$

① Calculate ΔV_{adj}

$$\Delta V_{adj} = \frac{f_g \Delta t}{1.466}$$

$$\Delta V_{adj} = \frac{(0.8)(0.150\,s)(32.2\,ft/s^2)}{1.466\,\frac{ft/s}{mi/h}} = \frac{\frac{ft}{s}}{\frac{\frac{ft}{s}}{\frac{mi}{h}}}$$

$$\frac{\frac{m}{s}}{s} = m/s^2$$

$$\frac{\frac{m}{s}}{\frac{s}{1}} = \frac{m}{s} \cdot \frac{1}{s} = \frac{m}{s^2}$$

$$\Delta V_{adj} = \frac{3.86}{1.466}$$

$$\Delta V_{adj} = 2.64 \text{ mph}$$

$$\frac{\frac{ft}{s}}{1} \cdot \frac{\frac{mi}{h}}{\frac{ft}{s}} = \frac{mi}{h}$$

② $\Delta V_{corr} = \Delta V_{EDR} \pm \Delta V_{adj}$

$\Delta V_{corr} = -8 + 2.64$ mph

$\Delta V_{corr} = -5.36$ mph

③ Calculate ΔV_{mL}

$$\Delta V_{mL} = -(\Delta V_{corr})\left(\frac{W_C}{W_{mL}}\right)$$

$$\Delta V_{mL} = -(-5.36)\left(\frac{4000}{800}\right)$$

$$\Delta V_{mL} = (5.36)(5)$$

$\Delta V_{mL} = 26.8$ mph

④ Calculate $V_{c,\Delta V}$

$$V_{c,\Delta V} = \left[\frac{1}{1+e}\right]\left[\frac{|\Delta V_1|}{x_1} + \frac{|\Delta V_2|}{x_2}\right]$$

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

$$V_{c,\Delta V} = \left[\frac{1}{1+0.1}\right][5.37 + 26.8]$$

$$V_{c,\Delta V} = \left(\frac{1}{1.1}\right)(32.16)$$

$$V_{c,\Delta V} = (0.9091)(32.16)$$

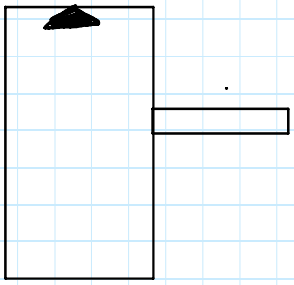
$V_{c,\Delta V} = 29.24$ mph

Car with EDR struck by another vehicle

INCREASE the magnitude of the EDR-reported delta-V.

$$\Delta v_{adj} = \frac{fg\Delta t}{1.466}$$

$$\Delta v_{cor} = \Delta v_1 \pm \Delta v_{adj}$$



$W_C = 4000$ lbs
$\Delta V_y = -8$ mph
$f = 0.8$
$\Delta t = 0.15$
$e = 0.1$

$W_{mL} = 800$ lbs
$\Delta V_{mL} =$
$V_{L,\Delta V} =$

① Calculate ΔV_{adj}

$$\Delta V_{adj} = \frac{fg\Delta t}{1.466}$$

$$\Delta V_{adj} = \frac{(0.8)(32.2)(0.150)}{1.466}$$

$$\Delta V_{adj} = \frac{3.86}{1.466}$$

$$\Delta V_{adj} = 2.64 \text{ mph}$$

② Calculate ΔV_{corr}

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

$$\Delta V_{corr} = -8 - 2.64$$

$$\Delta V_{corr} = -10.64$$

③ Calculate ΔV_{mL}

$$\Delta V_{mL} = -(\Delta V_{corr})\left(\frac{W_C}{W_{mL}}\right)$$

$$\Delta V_{mL} = -(-10.64)\left(\frac{4000}{800}\right)$$

$$\Delta V_{mL} = (10.64)(5)$$

$$\Delta V_{mL} = 53.2 \text{ mph}$$

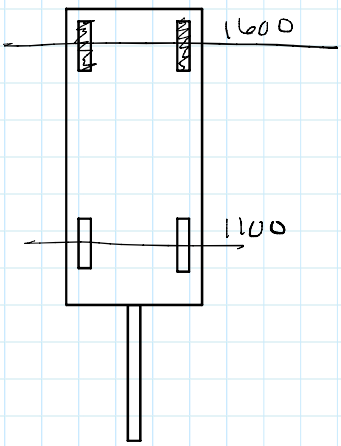
④ Calculate $V_{L,\Delta V}$

$$V_{L,\Delta V} = \left[\frac{1}{1+e}\right]\left[|\Delta V_1| + |\Delta V_2|\right]$$

$$V_{L,\Delta V} = \left[\frac{1}{1+0.1}\right]\left[|10.64| + |53.21|\right]$$

$$V_{L,\Delta V} = (0.9091)(63.85)$$

$$V_{L,\Delta V} = 58.05 \text{ mph}$$



$W_C = 2700$
$W_B = 1600$
$f = 0.7$
$\Delta V_{EDR} = 9$ mph
$\Delta t = 0.15$ s
$e = 0.05$

$W_{mL} = 800$
$\Delta V_{adj} =$
$V_{L,\Delta V} =$

① Calculate f_{adj}

$$f_{adj} = f\left(\frac{W_B}{W_C}\right)$$

$$f_{adj} = (0.7)\left(\frac{1600}{2700}\right)$$

② Calculate ΔV_{adj}

$$\Delta V_{adj} = \frac{f_{adj}\, g\, \Delta t}{1.466}$$

$$\Delta V_{adj} = \frac{(0.41)(32.2)(0.15)}{1.466}$$

$f_{adj} = (0.7)(0.59)$

$f_{adj} = 0.41$

$\Delta V_{adj} = \frac{1.98}{1.466}$

$\Delta V_{adj} = 1.35$ mph

③ Calculate ΔV_{corr}

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

$\Delta V_{corr} = 9 + 1.35$

$\Delta V_{corr} = 10.35$ mph

④ Calculate ΔV_{mc}

$\Delta V_{mc} = \Delta V_{corr}\left[\frac{W_c}{W_{MC}}\right]$

$\Delta V_{mc} = (10.35)\left[\frac{2700}{800}\right]$

$\Delta V_{mc} = (10.35)(3.38)$

$\Delta V_{mc} = 34.93$ mph

⑤ Calculate $V_{c,\Delta V}$

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

$V_{c,\Delta V} = \left[\frac{1}{1+0.05}\right]\left[10.35 + 34.93\right]$

$V_{c,\Delta V} = (0.9524)(45.27)$

$V_{c,\Delta V} = 43.11$ mph

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External Force Applied to the Vehicle without the EDR

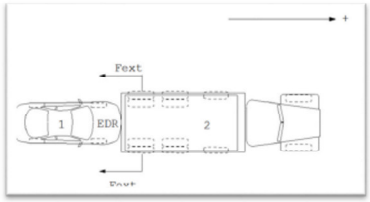
Example: Car with EDR hits a truck

Note: V1 is the car with the EDR

REDUCE the magnitude of the $\frac{w_1 \Delta v_{corr}}{w_2}$ term of the General Delta-V Equation

$$\Delta v_2 = -\left(\frac{w_1 \Delta V_{corr}}{w_2} \pm \frac{F_{ext} g \Delta t}{1.466 w_2}\right)$$

By adding or subtracting the $\frac{F_{ext} g \Delta t}{1.466 w_2}$ term of the General Delta-V Equation.



A 2200-pound car equipped with an EDR skids into the back of a parked 35,000-pound truck. The EDR reports a delta-V for the car of -30 MPH. Examination of the EDR data shows the crash pulse lasted 0.15 seconds. The friction coefficient for the car is .80 and for the truck .60. There is 20,000 pounds on the truck axles with parking brakes. The parking brake on the truck is set.

CAR

$W_c = 2200$ lbs

$\Delta V_{EDR} = -30$ mph

$f = 0.8$

$\Delta t = 0.15$ s

TRUCK

$W_T = 35,000$

$W_B = 20,000$

$f = 0.6$

1. Ignoring F_{ext} calculate ΔV_T

$\Delta V_T = \Delta V_c\left(\frac{W_c}{W_T}\right)$

$\Delta V_T = (30)\left(\frac{2200}{35000}\right)$

$\Delta V_T = (30)(0.0629)$

$\Delta V_T = 1.89$ mph

2. Ignoring F_{ext} Calculate $V_{c,\Delta V}$

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

$$V_{c,\Delta V} = \left[\frac{1}{1+0}\right]\left[30 + 1.89\right]$$

$V_{c,\Delta V} = 31.89$

3. Calculate ΔV_{adj}

$$\Delta V_{adj} = \frac{f_g \Delta t}{1.466}$$

$$\Delta V_{adj} = \frac{(0.8)(32.2)(0.15)}{1.466}$$

$$\Delta V_{adj} = \frac{3.864}{1.466}$$

$\Delta V_{adj} = 2.64$ mph

4. What is the ΔV of the car due to the crash?

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

$$\Delta V_{corr} = -30 + 2.64$$

$\Delta V_{corr} = -27.36$ mph

5. Calculate F_{ext} for the Truck

$$F_{ext} = W_B (f)$$

$$F_{ext} = (20000)(0.6)$$

$F_{ext} = 12{,}000$ lbs

6. Calculate the truck's ΔV

$$\Delta v_2 = -\left(\frac{w_1 \Delta V_{cor}}{w_2} \pm \frac{F_{ext} g \Delta t}{1.466 w_2}\right)$$

$$\Delta V_T = -\left[\frac{(22000)(-27.36)}{35000} \pm \frac{(12000)(32.2)(0.15)}{(1.466)(35000)}\right]$$

(ΔV_{adj})

$\Delta V_T = 1.72 \pm 1.13$

$\Delta V_T = 0.59$ mph

– h/c truck not the EDR vehicle

OR

$$f_{adj} = \left(\frac{W_B}{W_T}\right)(f)$$

$$f_{adj} = \left(\frac{20000}{35000}\right)(0.6)$$

$$\Delta V_{adj} = \frac{f_g \Delta t}{1.466}$$

$$\Delta V_{adj} = \frac{(0.34)(32.2)(0.15)}{1.466}$$

$$f_{adj} = \left(\frac{20000}{35000}\right)(0.6)$$

$$f_{adj} = (0.57)(0.6)$$

$$f_{adj} = 0.34$$

$$\Delta V_{adj} = \frac{(0.34)(50.2)(0.\quad)}{1.466}$$

$$\Delta V_{adj} = 1.12 \text{ mph}$$

7. Calculate $V_{c,\Delta v}$

$$V_{c,\Delta v} = \left[\frac{1}{1+e}\right]\left[|\Delta V_1| + |\Delta V_2|\right]$$

$$V_{c,\Delta v} = \left[\frac{1}{1+0}\right]\left[27.36 + 0.59\right]$$

$$V_{c,\Delta v} = 27.95 \text{ mph}$$