Solução corrigida do problema 6.73 e 6.74

Peso do carro com motorista

$M_a := 0$

$P_m := M_a \cdot g = 0$

$P_c := -1200kg \cdot g - P_m = -11.77 \cdot kN$ Peso do carro

6.73:

Primeiro caso só com o carro:

$d_{DB} := 1.2m \quad d_{DPc} := 2.8m \quad d_{DC} := 4m$

somatório de momentos na roda B, determina carga na roda C

$$R_C := \left(d_{DPc} - d_{DB}\right) \cdot P_c + \left(d_{DC} - d_{DB}\right) \cdot R_C = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_C \end{array} \right. \rightarrow -\frac{P_c \cdot \left(d_{DB} - d_{DPc}\right)}{d_{DB} - d_{DC}} = 6.72 \cdot kN$$

$\frac{R_C}{2} = 3.36 \cdot kN$ Carga na roda C

$$R_B := R_C + P_c + R_B = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_B \end{array} \right. \rightarrow -P_c - R_C = 5.04 \cdot kN$$

$\frac{R_B}{2} = 2.52 \cdot kN$ Carga na roda B

Caso do trailer com o carro e com o motorista

$d_{DA} := -3.7m \quad d_{DPt} := -3.2m$

$P_t := -1050kg \cdot g = -10.3 \cdot kN$ Peso do trailer

Somatório dos monentos em D determina a carga na roda A

$$R_A := d_{DA} \cdot R_A + d_{DPt} \cdot P_t = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_A \end{array} \right. \rightarrow -\frac{P_t \cdot d_{DPt}}{d_{DA}} = 8.91 \cdot kN \quad \frac{R_A}{2} = 4.45 \cdot kN$$ Carga na roda A

Somatório das forças a carga que o trailer receb do apoio no engate

$$F_{Dt} := R_A + P_t + F_D = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, F_D \end{array} \right. \rightarrow -P_t - R_A = 1.391 \cdot kN$$

somatório de momentos na roda B, determina carga na roda C com o peso do trailer no engate

$F_{Dc} := -F_{Dt} = -1.391 \cdot kN$

$$R_{Cc} := -d_{DB} \cdot F_{Dc} + \left(d_{DPc} - d_{DB}\right) \cdot P_c + \left(d_{DC} - d_{DB}\right) \cdot R_{Cc} = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_{Cc} \end{array} \right. \rightarrow -\frac{F_{Dc} \cdot d_{DB} + P_c \cdot \left(d_{DB} - d_{DPc}\right)}{d_{DB} - d_{DC}}$$

$\frac{R_{Cc}}{2} = 3.064 \cdot kN$ Carga nas rodas C com o trailer acoplado simples

Somatório das forças determina a carga na roda B com o trailer acoplado

$$R_{Bc} := F_{Dc} + R_{Bc} + P_c + R_{Cc} = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_{Bc} \end{array} \right. \rightarrow -F_{Dc} - P_c - R_{Cc} = 7.031 \cdot kN$$

$\frac{R_{Bc}}{2} = 3.516 \cdot kN$ Craga nas rodas B

$\frac{R_{Bc} - R_B}{2} = 994 \cdot N$ Carga adicional na roda traseira do carro devido ao trailer

$\frac{R_{Cc} - R_C}{2} = -298 \cdot N$ Carga subtraida da roda dianteira pelo peso do Trailer

$R_A + R_{Bc} + R_{Cc} + P_t + P_c = -0\,N$ Verificação do equlibrio

6.74 Caso do trailer com sistema de equilíbrio nas rodas

$d_{DE} := -.5m$ Distância ao dispostivo de compensdação

Somatório dos momentos em D para descobrir a carga na roda A (trailer com a compensação)

$$d_{DE}\cdot F_{Et} + d_{DA}\cdot R_{Atc} + d_{DPt}\cdot P_t = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_{Atc} \end{array} \right. \rightarrow -\frac{F_{Et}\cdot d_{DE} + P_t\cdot d_{DPt}}{d_{DA}}$$

Somatório das força no trailer compensado

$$F_{Et} + R_{Atc} + P_t + F_{Dtc} = 0 \left| \begin{array}{l} \text{explicit} \\ \text{substitute}, R_{Atc} = -\frac{F_{Et}\cdot d_{DE} + P_t\cdot d_{DPt}}{d_{DA}} \end{array} \right. \rightarrow \frac{F_{Et}\cdot d_{DA} - F_{Et}\cdot d_{DE} + F_{Dtc}\cdot d_{DA} + P_t\cdot d_{DA} - P_t\cdot d_{DPt}}{d_{DA}} = 0$$

$$\frac{F_{Et}\cdot d_{DA} - F_{Et}\cdot d_{DE} + F_{Dtc}\cdot d_{DA} + P_t\cdot d_{DA} - P_t\cdot d_{DPt}}{d_{DA}} = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, F_{Et} \end{array} \right. \rightarrow -\frac{F_{Dtc}\cdot d_{DA} + P_t\cdot d_{DA} - P_t\cdot d_{DPt}}{d_{DA} - d_{DE}}$$

Transferindo as forças no engate compensador para o carro

$F_{Dcc} = -F_{Dtc}$ $F_{Ec} = -F_{Et}$

$$F_{Ec} = \frac{F_{Dtc}\cdot d_{DA} + P_t\cdot d_{DA} - P_t\cdot d_{DPt}}{d_{DA} - d_{DE}} \left| \begin{array}{l} \text{explicit} \\ \text{substitute}, F_{Dtc} = -F_{Dcc} \end{array} \right. \rightarrow F_{Ec} = -\frac{F_{Dcc}\cdot d_{DA} - P_t\cdot d_{DA} + P_t\cdot d_{DPt}}{d_{DA} - d_{DE}}$$

Somatório dos momentos em D para descobrir FE no caso de mesma carga nas rodas dianteiras e traserias

$R_{Bcc} = R_{Ccc}$

$$d_{DE}\cdot F_{Ec} + d_{DB}\cdot R_{Bcc} + d_{DPc}\cdot P_c + d_{DC}\cdot R_{Bcc} = 0 \left| \begin{array}{l} \text{explicit} \\ \text{solve}, R_{Bcc} \end{array} \right. \rightarrow -\frac{F_{Ec}\cdot d_{DE} + P_c\cdot d_{DPc}}{d_{DB} + d_{DC}}$$

$$R_{Bcc} = -\frac{F_{Ec}\cdot d_{DE} + P_c\cdot d_{DPc}}{d_{DB} + d_{DC}} \left| \begin{array}{l} \text{explicit} \\ \text{substitute}, F_{Ec} = -\frac{F_{Dcc}\cdot d_{DA} - P_t\cdot d_{DA} + P_t\cdot d_{DPt}}{d_{DA} - d_{DE}} \end{array} \right. \rightarrow R_{Bcc} = \frac{P_c\cdot d_{DE}\cdot d_{DPc} - P_c\cdot d_{DA}\cdot d_{DPc} - P_t\cdot d_{DA}\cdot d_{DE} + P_t\cdot d_{DE}\cdot d_{DPt} + F_{Dcc}\cdot d_{DA}\cdot d_{DE}}{\left(d_{DA} - d_{DE}\right)\cdot\left(d_{DB} + d_{DC}\right)}$$

$$R_{Bcc} = \frac{P_c\cdot d_{DE}\cdot d_{DPc} - P_c\cdot d_{DA}\cdot d_{DPc} - P_t\cdot d_{DA}\cdot d_{DE} + P_t\cdot d_{DE}\cdot d_{DPt} + F_{Dcc}\cdot d_{DA}\cdot d_{DE}}{\left(d_{DA} - d_{DE}\right)\cdot\left(d_{DB} + d_{DC}\right)}$$

Somatório das forças no carro

$$F_{Ec} + F_{Dcc} + 2\cdot R_{Bcc} + P_c = 0 \left| \begin{array}{l} \text{explicit} \\ \text{substitute}, F_{Ec} = -\frac{F_{Dcc}\cdot d_{DA} - P_t\cdot d_{DA} + P_t\cdot d_{DPt}}{d_{DA} - d_{DE}} \end{array} \right. \rightarrow -\frac{F_{Dcc}\cdot d_{DE} - P_c\cdot d_{DA} + P_c\cdot d_{DE} - P_t\cdot d_{DA} + P_t\cdot d_{DPt} - 2\cdot R_{Bcc}\cdot d_{DA} + 2\cdot R_{Bcc}\cdot d_{DE}}{d_{DA} - d_{DE}} = 0$$

$$-\frac{F_{Dcc}\cdot d_{DE} - P_c\cdot d_{DA} + P_c\cdot d_{DE} - P_t\cdot d_{DA} + P_t\cdot d_{DPt} - 2\cdot R_{Bcc}\cdot d_{DA} + 2\cdot R_{Bcc}\cdot d_{DE}}{d_{DA} - d_{DE}} = 0 \left| \begin{array}{l} \text{explicit} \\ \text{substitute}, R_{Bcc} = \frac{P_c\cdot d_{DE}\cdot d_{DPc} - P_c\cdot d_{DA}\cdot d_{DPc} - P_t\cdot d_{DA}\cdot d_{DE} + P_t\cdot d_{DE}\cdot d_{DPt} + F_{Dcc}\cdot d_{DA}\cdot d_{DE}}{\left(d_{DA} - d_{DE}\right)\cdot\left(d_{DB} + d_{DC}\right)} \end{array} \right. \rightarrow -\frac{P_c\cdot d_{DB}\cdot d_{DE} - P_c\cdot d_{DA}\cdot d_{DC} - P_c\cdot d_{DA}\cdot d_{DB} + P_c\cdot d_{DC}\cdot d_{DE} - P_t\cdot d_{DA}\cdot d_{DB} - P_t\cdot d_{D}}{}$$

$$-\frac{P_c\cdot d_{DB}\cdot d_{DE}-P_c\cdot d_{DA}\cdot d_{DC}-P_c\cdot d_{DA}\cdot d_{DB}+P_c\cdot d_{DC}\cdot d_{DE}-P_t\cdot d_{DA}\cdot d_{DB}-P_t\cdot d_{DA}\cdot d_{DC}+2\cdot P_t\cdot d_{DA}\cdot d_{DE}+2\cdot P_c\cdot d_{DA}\cdot d_{DPc}-2\cdot P_c\cdot d_{DE}\cdot d_{DPc}+P_t\cdot d_{DB}\cdot d_{DPt}+P_t\cdot d_{DC}\cdot d_{DPt}-2\cdot P_t\cdot d_{DE}\cdot d_{DPt}-2\cdot F_{Dcc}\cdot d_{DA}\cdot d_{DE}+F_{Dcc}\cdot d_{DB}\cdot d_{DE}+F_{Dcc}\cdot d_{DC}\cdot d_{DE}}{\left(d_{DA}-d_{DE}\right)\cdot\left(d_{DB}+d_{DC}\right)}=0\ \left|\begin{array}{l}\text{explicit}\\ \text{solve},F_{Dcc}\end{array}\right.\rightarrow\frac{P_c\cdot d_I}{}$$

$$F_{Dcc}:=\frac{P_c\cdot d_{DA}\cdot d_{DB}+P_c\cdot d_{DA}\cdot d_{DC}-1.0\cdot P_c\cdot d_{DB}\cdot d_{DE}-1.0\cdot P_c\cdot d_{DC}\cdot d_{DE}+P_t\cdot d_{DA}\cdot d_{DB}+P_t\cdot d_{DA}\cdot d_{DC}-2.0\cdot P_t\cdot d_{DA}\cdot d_{DE}-2.0\cdot P_c\cdot d_{DA}\cdot d_{DPc}+2.0\cdot P_c\cdot d_{DE}\cdot d_{DPc}-1.0\cdot P_t\cdot d_{DB}\cdot d_{DPt}-1.0\cdot P_t\cdot d_{DC}\cdot d_{DPt}+2.0\cdot P_t\cdot d_{DE}\cdot d_{DPt}}{d_{DB}\cdot d_{DE}-2.0\cdot d_{DA}\cdot d_{DE}+d_{DC}\cdot d_{DE}}=-2.676\cdot kN$$

$$F_{Ec}:=-\frac{F_{Dcc}\cdot d_{DA}-P_t\cdot d_{DA}+P_t\cdot d_{DPt}}{d_{DA}-d_{DE}}=1.485\cdot kN$$

$$R_{Bcc}:=\frac{P_c\cdot d_{DE}\cdot d_{DPc}-P_c\cdot d_{DA}\cdot d_{DPc}-P_t\cdot d_{DA}\cdot d_{DE}+P_t\cdot d_{DE}\cdot d_{DPt}+F_{Dcc}\cdot d_{DA}\cdot d_{DE}}{d_{DA}\cdot d_{DB}+d_{DA}\cdot d_{DC}-d_{DB}\cdot d_{DE}-d_{DC}\cdot d_{DE}}=6.479\cdot kN$$

$R_{Ccc}:=R_{Bcc}=6.48\cdot kN$ Carga no eixo dianteiro e traseiros equilibrados $\frac{R_{Bcc}}{2}=3.24\cdot kN$

$F_{Et}:=-F_{Ec}=-1.485\cdot kN$

$F_{Dtc}:=-F_{Dcc}=2.676\cdot kN$ Carga na rótula equlibrada

$R_{Atc}:=-\frac{F_{Et}\cdot d_{DE}+P_t\cdot d_{DPt}}{d_{DA}}=9.106\cdot kN$ Carga no eixo do trailer com o sistema equilibrado equilibrado $\frac{R_{Atc}}{2}=4.55\cdot kN$

$R_{Atc}+R_{Bcc}+R_{Ccc}+P_t+P_c=0\cdot kN$ Verificação do equilibrio