$D_1 = 125 \quad D_2 = 271 \quad C = 458$

$\therefore \gamma = \arcsin (271-125)/(2 \times 458) = 9.17^\circ$

So, for various ϕ_1 from (vi)

a) $\begin{cases} s = h_x \sin(\phi + 9.17) - (-150)\cos(\phi + 9.17) + 62.5 \\ t = h_x \sin(\phi - 9.17) - (-150)\cos(\phi - 9.17) - 62.5 \end{cases}$

where h_x remains to be chosen.

From (6)

b) $t\hat{f} + s\check{f} = h_x$

From (4a)

c) $\hat{f} - \check{f} = P/Wv = \dfrac{3930}{36 \times 9.81 \times 9.4} = 1.18$

where 15% is added to the motor's bare mass to allow for base frame. hence $m = 31 \times 1.15 \doteq 36$ kg.

The limiting tension ratio, from (3)

$(f\theta)_1 = 1/6 \operatorname{cosec} 19^\circ (\pi - 2 \times 9.17^\circ) = 1.444$

$(f\theta)_2 = 1/6 \operatorname{cosec} 20^\circ (\pi + 2 \times 9.17^\circ) = 0.577$

d) $\therefore \hat{f}/\check{f} \leq e^{(f\theta)\min} = e^{0.577} = 1.781$

The solution process involves selecting a likely looking h_x. For various ϕ, the slack and tight side moment arms s and t follow from a). The normalised tensions $\hat{f}$ and $\check{f}$ then follow from simultaneous solution of b) and c) — their ratio must satisfy d).

A short program was written to display results, with output shown overleaf.

The first graph is for $h_x = 250$ mm. This is unsatisfactory because viable solutions appear only in the window

— from $\phi \approx -20^\circ$, when $\hat{f}, \check{f} \to \infty$

— to $\phi \approx -12^\circ$, when $\hat{f}/\check{f} = 1.78$

and similarly $135^\circ \lesssim \phi \lesssim 140^\circ$.

The same sort of behaviour was evident for other h_x, which pointed to need for weight augmentation.

Experimenting with the program eventually led to the second plot, still with $h_x = 250$ mm. But now $P/Wv = 0.25$

i.e. $W_{\text{motor effective}} = \dfrac{3930}{9.81 \times 9.4 \times 0.25} = 170$ kg.