1 Introduction

This article provides additional guidance on Train Physical Data, supplementing section 8.2 of the SES Users' Manual.

2 Acceleration Resistance of Rotating Parts

The Acceleration Resistance of Rotating Parts is a factor which is used to increase the effective mass of the train to allow for the rotational inertia of the wheels, motors, axles, etc. The train effective mass consists of two parts: the empty car mass, which is modified by a factor to account for the acceleration resistance of rotating parts, and the mass of the passengers.

The modified empty car mass is

$$m_{\mathrm{v,mod}} = m_{\mathrm{v}} \left(1 + f_{\mathrm{acc}}\right) \tag{1}$$

where f_{acc} is a coefficient representing the effective mass of rotating parts relative to the car mass. SES is coded in such a way that f_{acc} cannot be set directly. The corresponding user input is the Acceleration Resistance of Rotating Parts, R_{acc}, with units lbf/(ton-mph/sec). The two parameters are related by a unit conversion factor, f_{c},

$$f_{\mathrm{acc}} = \frac{R_{\mathrm{acc}}}{f_{\mathrm{c}}} \tag{2}$$

$$\begin{aligned} f_{\mathrm{c}} &= \frac{2000\,\frac{\mathrm{lb}}{\mathrm{ton}} \times 5280\frac{\mathrm{ft}}{\mathrm{mil}}}{32.174\,\frac{\mathrm{ft}}{\mathrm{s}^2} \times 3600\,\frac{\mathrm{s}}{\mathrm{hr}}} \\ &= 91.2\,\frac{\mathrm{lb}}{\mathrm{ton}}\frac{\mathrm{s\,hr}}{\mathrm{mil}} \end{aligned} \tag{3}$$

If the acceleration resistance of rotating parts is to be estimated as a fraction of the vehicle mass, then it can be converted to the appropriate SES input using equation 2. The default value of 8.8 lbs per ton/(mph/sec) corresponds to 9.6% of the car mass.

The implementation of equation 1 in the SES source code is as follows. The train acceleration is calculated in the `TRAIN` subroutine (line 198),

```
C*****FIND ACCELERATION TRAIN IS CAPABLE OF
      DUDTV(NUMV)=(TEV(NUMV)*MOTORV(ITYP)-RSISTV(NUMV))/(WV(ITYP)*RRACC(
     1ITYP)+WPATV(NUMV)/GRACC)
```

where the modified empty car mass (equation 1) appears as the term `WV(ITYP)*RRACC(ITYP)`. Note that the variable `RRACC(ITYP)` is redefined when initially read by the `GARAGE` subroutine (line 307):

```
       RRACC(I) = ( 91.2 + RRACC(I) ) / ( 91.2 * GRACC )
```

Equation 1 can be recovered from the above source code as follows,

$$
\begin{aligned}
R_{\mathrm{racc}} &= \frac{91.2 + R_{\mathrm{acc,input}}}{91.2g} = \frac{f_{\mathrm{c}} + R_{\mathrm{acc,input}}}{f_{\mathrm{c}}g} \\
m_{\mathrm{v,mod}} &= w_{\mathrm{v}} R_{\mathrm{acc}} = \frac{w_{\mathrm{v}}(f_{\mathrm{c}} + R_{\mathrm{acc,input}})}{f_{\mathrm{c}}g} \\
&= \frac{w_{\mathrm{v}}}{g} + \frac{w_{\mathrm{v}} R_{\mathrm{acc,input}}}{f_{\mathrm{c}}g} \\
&= m_{\mathrm{v}} + \frac{R_{\mathrm{acc,input}}}{f_{\mathrm{c}}} m_{\mathrm{v}} \\
&= m_{\mathrm{v}} \left(1 + f_{\mathrm{acc}}\right)
\end{aligned}
$$

where w_{v} is car weight, g is gravitational acceleration and the subscript ‘input’ indicates the original R_{acc} defined by the user.