Mathematical Models to Describe Vechile Performance

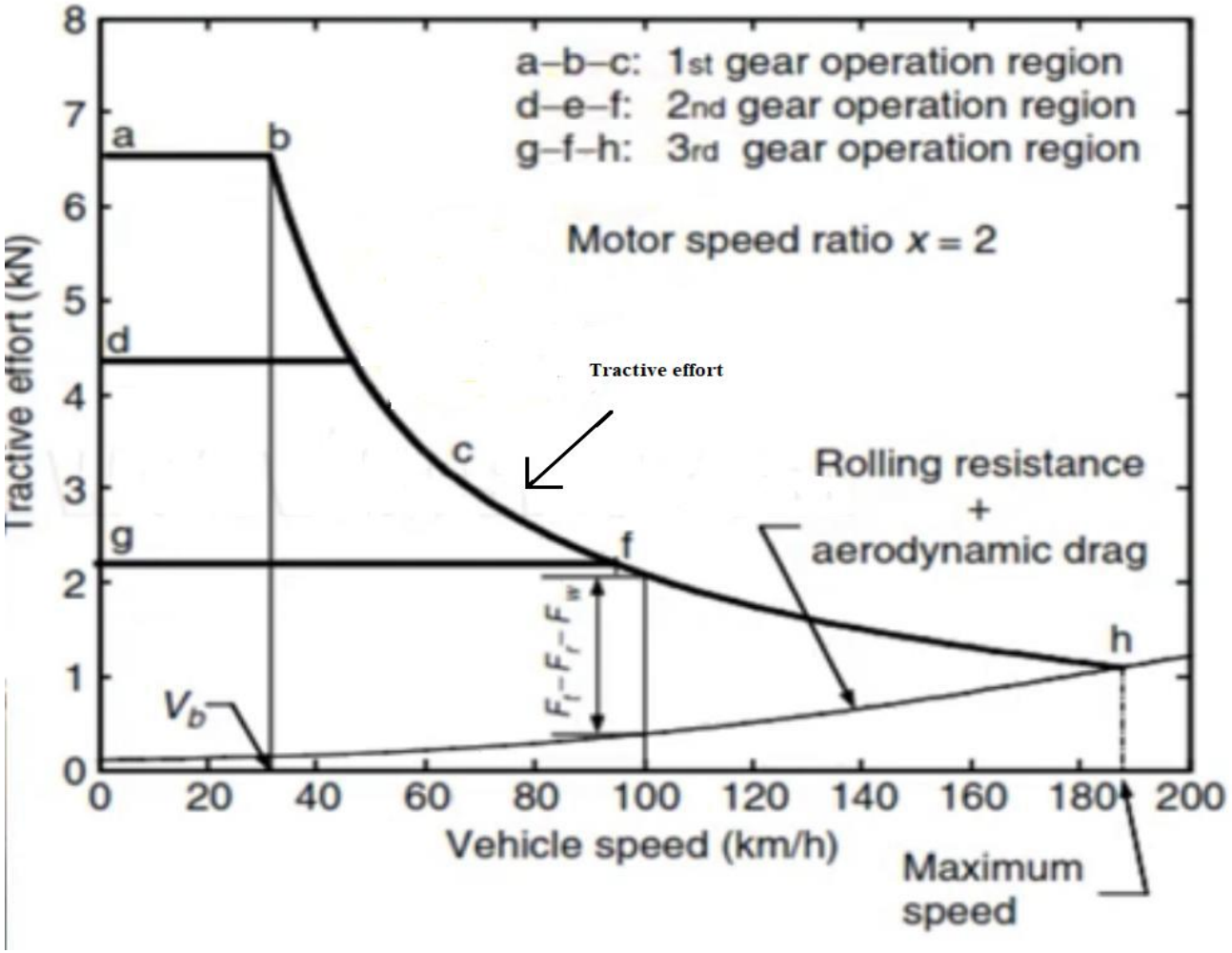
Basic vehicle performance includes

- Maximum cruising speed
- Grade ability
- Acceleration

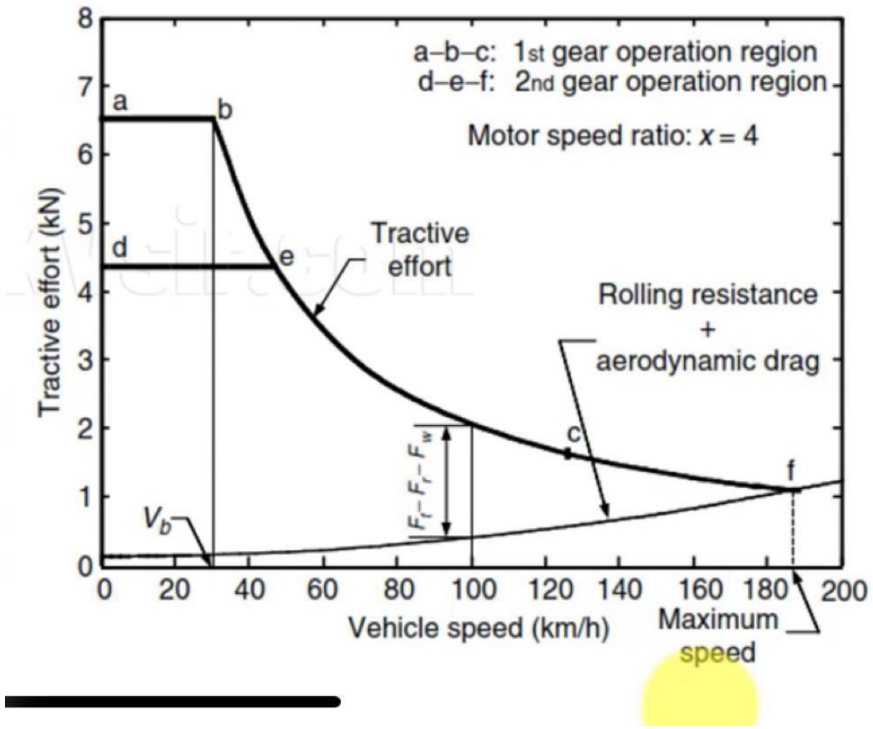
Maximum Speed

- The maximum speed of a vehicle can be easily found two methods.
- First is Graphical Method where the intersection point of the tractive effort curve with the resistance curve (rolling resistance plus aerodynamic drag), in the tractive effort vs. vehicle speed diagram
- Second Method is by direct formals Method

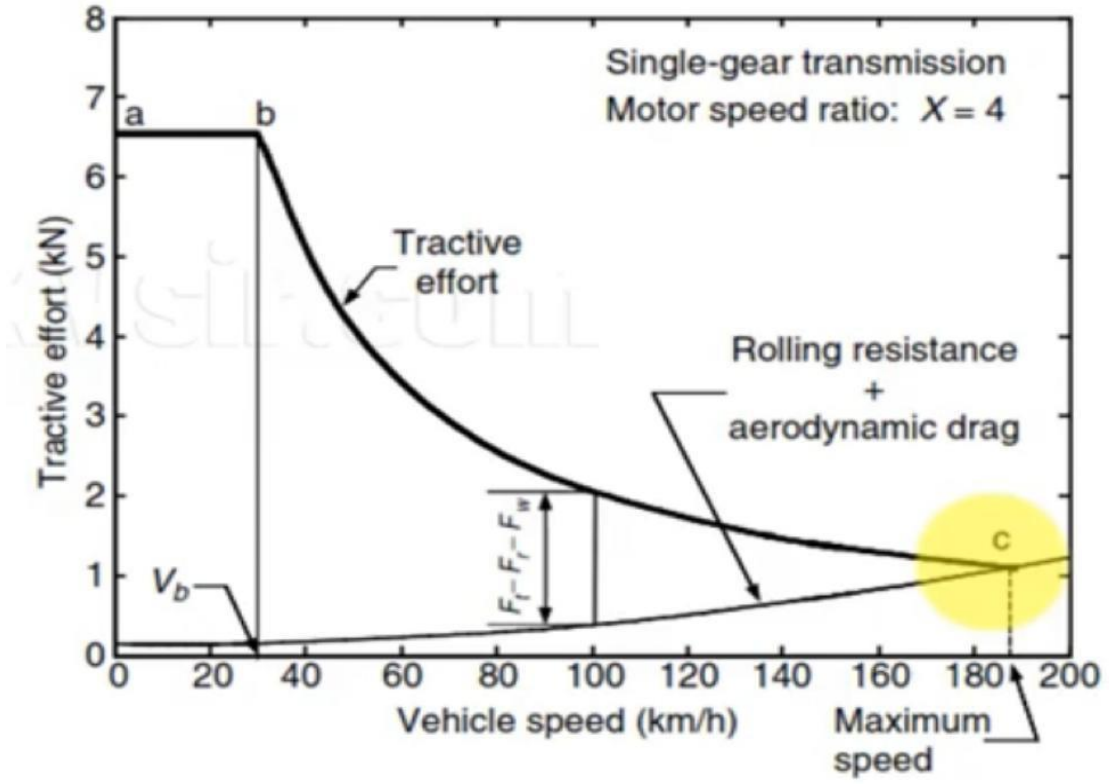
The maximum speed of a vehicle can be found by the intersection point of the tractive effort curve with the resistance curve (rolling resistance + aerodynamic drag), in the tractive effort vs vehicle speed diagram for 3 GEAR.



Similarly, tractive effort vs. vehicle speed diagram for TWO GEAR shown in this Figures:
Tractive effort vs vehicle speed with a traction motor of X = 4



Similarly, tractive effort vs. vehicle speed diagram for ONE GEAR shown in this Figures: Tractive effort vs vehicle speed with a traction motor of X = 6



Alternate Method By Formula

But intersection point does not exist in some designs, which usually use a larger traction motor or a large gear ratio. In such case, the maximum vehicle speed is determined by the maximum speed of the traction motor as

$$V_{max} = \frac{\pi N_{m\,max} r_d}{30 i_{g\,min} i_0} (\text{m/s}),$$

Where:

$N_{m\,max}$ = Maximum allowed rpm of Traction Motor

r_d = Dynamic Radius of driving wheel

$i_{g\,min}$ = Minimum gear ratio of the transmission of Highest gear

i_0 = Gear ratio of final drive

Grade Ability

Grade ability is determined by the net tractive effort of the vehicle, Ft-net (Ft-net= Ft-Fr-Fw), as shown in previous three figures. At mid and high speeds, the grade ability is smaller than the grade ability at low speeds.The maximum grade that the vehicle can overcome at the given speed can be calculated by

$$i = \frac{F_{t\text{-}net}}{M_v g} = \frac{F_t - (F_r + F_w)}{M_v g},$$

Where:

F_t = Tractive effort on driving wheel

F_r = Tyre rolling resistance

F_w = Aerodynamic Drag

i_0 = Gear ratio of final drive

At low speeds, the gradeability is much larger.

ACCELERATION

- Vehicle Mass Factor (Constant] also called vehicle rotational inertial constant which is used because rotational energy is converting to linear energy of vehicle.
- Energy per unit time is power
- Similarly this rough calculation will give us

$$P_t = \frac{\delta M_v}{2t_a}(V_f^2 + V_b^2).$$

THANK YOU