TRAFFIC ENGINEERING

Civil Engineering Department

Lecturer Sady Abd Tayh
Lecturer Rana Amir Yousif

Third Class

2018-2019

Dynamic Characteristics

A vehicle in motion has to overcome the resistance of the air, the resistance due to rolling, resistance offered by the grade, the friction resistance.

Air Resistance

$$F_a = 0.5 \frac{2.15 \rho C_D A V^2}{g}$$

where:

F_a : air resistance force (lb).

ρ: density of air (0.002385 lb/ft^3) at seelevel.
C_D: aerodynamic drag coefficient. (0.4 typically)
range (0.15 - 0.5).
A: frontal cross-sectional area (ft)^2.
V: vehicle speed (mph).
g: acceleration due to gravity (32.2 ft/sec^2).

Rolling Resistance

$R_r = (C_{rs} + 2.15\, C_{rv} V^2) W$ ----- for passenger cars.

$R_r = (C_a + 1.47\, C_b V) W$ ----- for truck.

where:
R_r: rolling resistance force (lb).
C_{rs}: constant (typically, 0.012 for passenger cars).
C_{rv}: constant (typically, 0.65×10^{-6} sec^2/ft for passenger cars).
C_a: constant (typically, 0.2445 for trucks).
C_b: constant (typically, 0.00044 sec/ft for trucks).
V: vehicle speed (mph).
W: gross vehicle weight (lb).

Power Requirement

Power is the rate at which work is done. It is usually expressed in horsepower.

1 horsepower = 550 lb.ft/ft

$$P = \frac{1.47\,RV}{550}$$

Where:

P: horse power delivered (hp).
R: sum of resistance to motion.
V: speed of vehicle.

Example: determine the horsepower produced by a passenger car traveling at a speed of 60 mph on a straight flat road with a smooth pavement. Assume the weight of the car is 4000 lb and the cross-sectional area of the car is 40 ft^2.

Solution:

R = (air resistance) + (rolling resistance)

$$F_a = 0.5\left(\frac{2.15 \times 0.002385 \times 0.4 \times 40 \times 60 \times 60}{32.2}\right)$$

$F_a = 4.58$ lb

$R_r = (C_{rs} + 2.15\, C_{rv} V^2) W$

$= (0.012 + 2.15 \times 0.65 \times 10^{-6} \times 60 \times 60) \times 4000$

$R_r = 68$ Ib

The total resistance;

$R = F_a + R_r$

$R = 4.58 + 68 = 72.58$ Ib

$P = \frac{1.47 \times 72.58 \times 60}{550} = 11.6$ hp