

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 Ib/ft^3) at sea level.

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

$$R_r = (C_{rs} + 2.15 C_{rv} v^2) W \quad \text{--- For passenger cars.}$$

$$R_r = (C_a + 1.47 C_b v) W \quad \text{--- For truck.}$$

Where:

R_r : rolling resistance force (Ib).

C_{rs} : constant (typically, 0.012 For passenger cars).

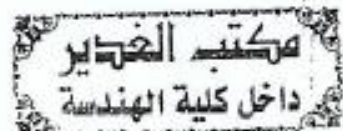
C_{rv} : constant (typically, $0.65 \times 10^{-6} \text{ sec}^2/\text{ft}$ For passenger cars).

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 (Ib).



Power Requirement

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

$$1 \text{ horsepower} = 550 \text{ Ib. Ft/ft}$$

$$P = \frac{1.47 R V}{550}$$

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 Ib and the cross-sectional area of the car is 40 ft².

Solution:

$$R = (\text{air resistance}) + (\text{rolling resistance})$$

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

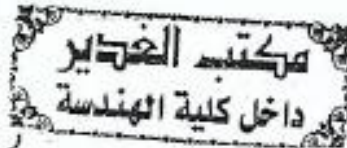
$$F_a = 4.58 \text{ Ib}$$

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

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

$$R_r = 68 \text{ Ib}$$

The total resistance,



$$R = F_a + R_r$$

$$R = 4.58 + 68 = 72.58 \text{ Ib}$$

$$P = \frac{1.47 \times 72.58 \times 60}{550} = 11.8 \text{ hp}$$