University of Al-Maarif

College of Engineering
Department of Civil Engineering

TRAFFIC ENGINEERING

THIRD LECTURE

Lecturer:

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Dynamic Characteristics of the Vehicle

Inertia resistance (Fi): the force required by a vehicle to overcome the tendency to remain at rest or remain in motion in straight line with a constant speed

Fi = m × a , m : vehicles mass (Kg) , a = vehicles acceleration (m/sec^2)

* (Fi) be (+) positive where there is acceleration (+ a)

*(Fi) be (-) negative where there is deceleration (- a)

Air resistance (Fa): the force required by a vehicle to move air from a vehicles pathway as well as to overcome the frictional effects of air with vehicle side top and under.

$$Fa = 0.5 * C_d * \rho * A * V^2$$

Where C_d is aerodynamic drag resistance, C_d = P.C typical value = o.4,
ρ = air density (kg/m^3) = 0.0382 kg/m^3 , A = Frontal cross-section area (m^2)

C_d = 0.363 (P.C with close windows)

C_d = 0.381 (P.C with open windows)

C_d = 0.5-0.8 (Truck)

Dynamic Characteristics of the Vehicle

Grade resistance (Fg): the force required by a vehicle to overcome the component of gravitational force acting on frictionless inclined surface (Wsinθ)

W= m.g

$$\boldsymbol{Fg = Wsin\theta = m.g \sin \theta}$$

For most highway applications θ is small, so sin Θ = tan Θ = G

$$\boldsymbol{\therefore Fg = m.g * \frac{G}{100}}$$

where g = 9.81 m/sec^2 , G = grade (slope) in percent .

Rolling resistance (Fr) : the force required by a vehicle to overcome the friction effects of moving parts of vehicles as well as the friction between tire and pavement surface .

$$Fr = \frac{m.g}{100} * (1 + \frac{V}{44.73})$$

Where V = vehicles speed m/sec = V km/hr ×0.278

Dynamic Characteristics of the Vehicle

Power Requirement: The engine-generated power requirement to overcome the opposing resistances.

$$P = F * V$$

$$R = F = Fi + Fa + Fg + Fr + Fc^{*}$$

Where R in (watts) power or (hp) horse-power

hp = 750 watts = 0.75 Kilo watts

Dynamic Characteristics of the Vehicle

Breaking distance (db): distance needed to stop the vehicle after applying brake (skid distance)

$$db = \frac{V^2}{254(F_b \mp G)}$$

Where:

V : initial speed (Km/hr), design speed.

F_b : coefficient of frication due to breaking

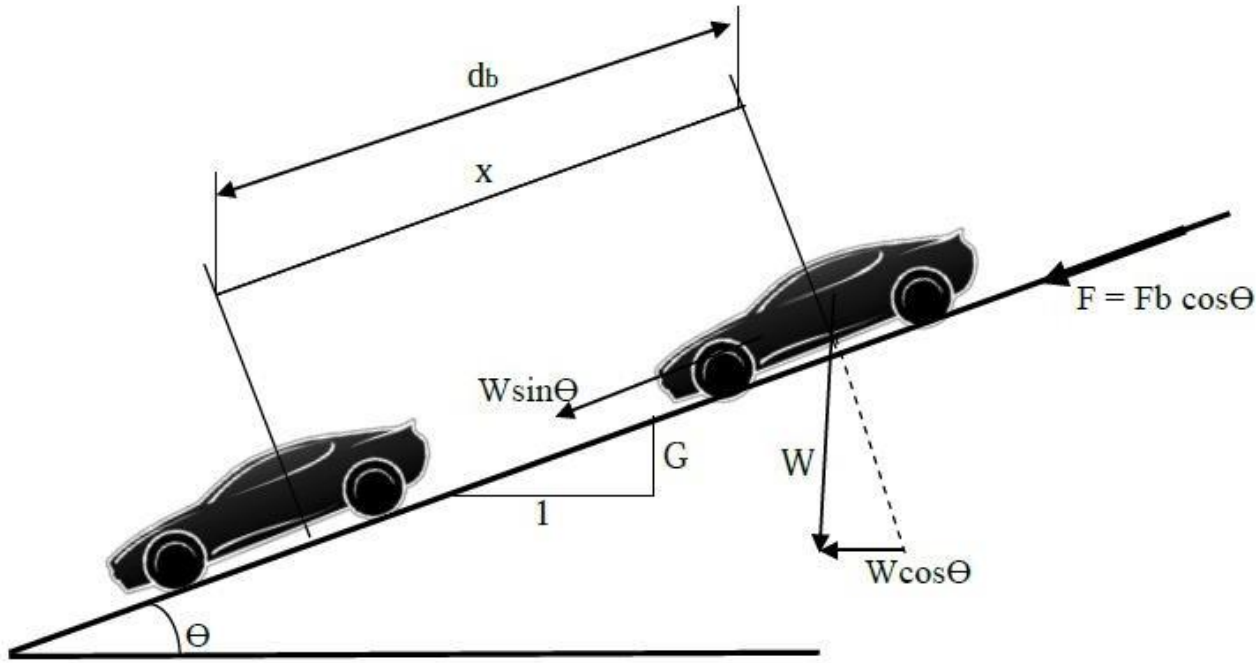
G = grade in percent (%), + G = upgrade, - G = downgrade

F_b	Condition
0.45-0.62	dry pavement
0.28-0.4	wet pavement
0.1	muddy pavement
0.05	icy pavement

Dynamic Characteristics of the Vehicle

Breaking distance (db): distance needed to stop the vehicle after applying brake (skid distance)

$$db = \frac{V^2}{254(F_b \mp G)}$$



Dynamic Characteristics of the Vehicle

Sight Distance : Sight distance is the length of the roadway visible ahead at any time. The sight distance available at each point of the highway must be such that, when a driver is traveling at the highways design speed, adequate time is given after an object is observed in the vehicles path to make the necessary evasive maneuvers without colliding with the object. The two types of sight distance are **(1) stopping sight distance** and **(2) passing sight distance**.

Stopping sight distance (SSD) : for design purposes, is usually taken as **the minimum sight distance required for a driver to stop a vehicle after observing an object in the vehicles path without ahead hitting that object**. This distance is the sum of the distance traveled during perception-reaction time and the distance traveled during braking. The SSD for a vehicle traveling at ***V*** km/hr is given by

$$SSD = 0.278V.t + \frac{V_i^2 - Vf^2}{254(F_b \mp G)}$$

Dynamic Characteristics of the Vehicle

Turning Radius (R) : When a vehicle is moving around a circular curve, there is outward radial force acting on the vehicle, usually referred to as the centrifugal force. Which may cause the vehicle to slide outward or overturning.

$$\boldsymbol{Centerfugal\ Force} \quad (\boldsymbol{Fc}) = \boldsymbol{m} * \boldsymbol{a} = \frac{\boldsymbol{W.a}}{\boldsymbol{g}} = \frac{\boldsymbol{W}}{\boldsymbol{9.81}} * \frac{\boldsymbol{V^2}}{\boldsymbol{R}}$$

Where a = acceleration for curve motion

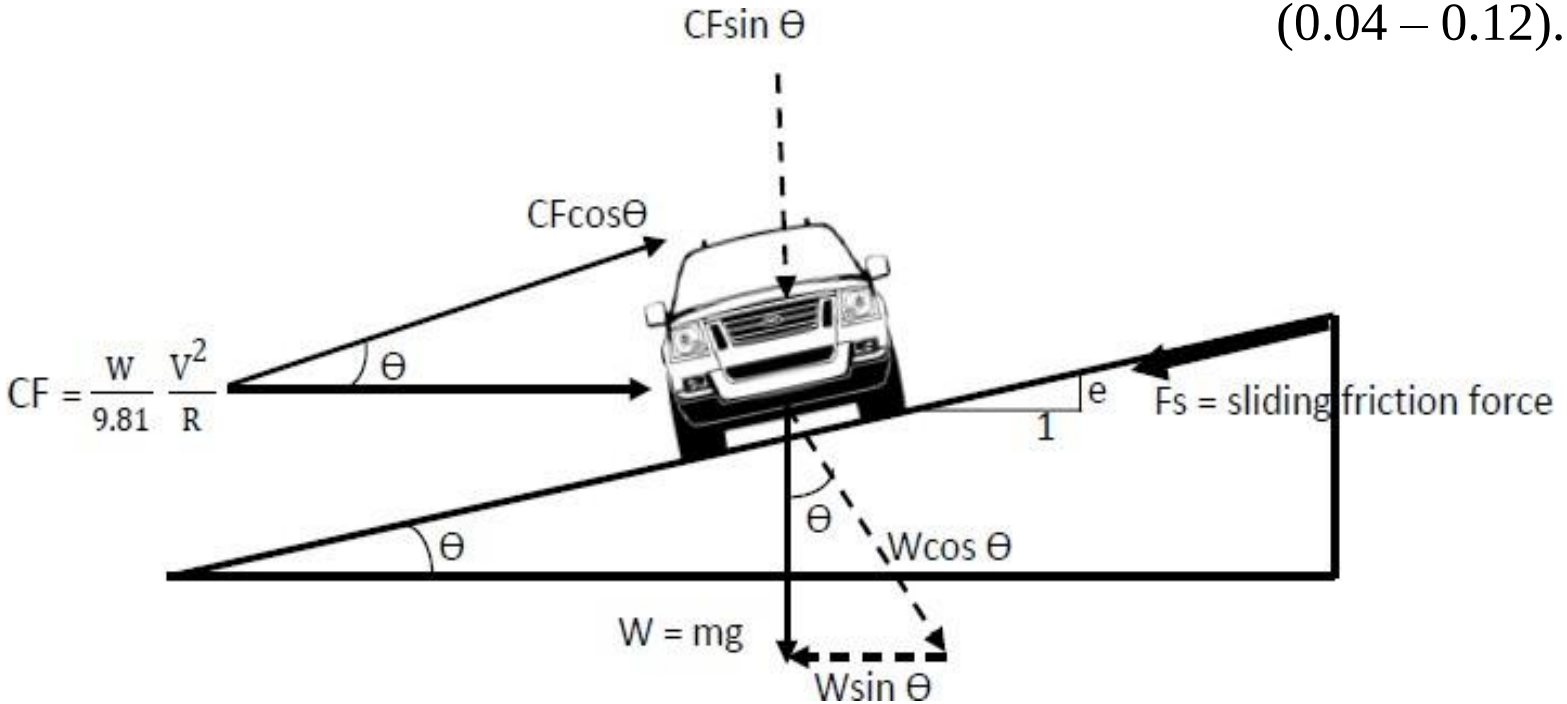
In order to balance the effect of the centripetal acceleration, the road is inclined toward the center of the curve. The inclination of the roadway toward the center of the curve is known as **SUPERELEVATION**.

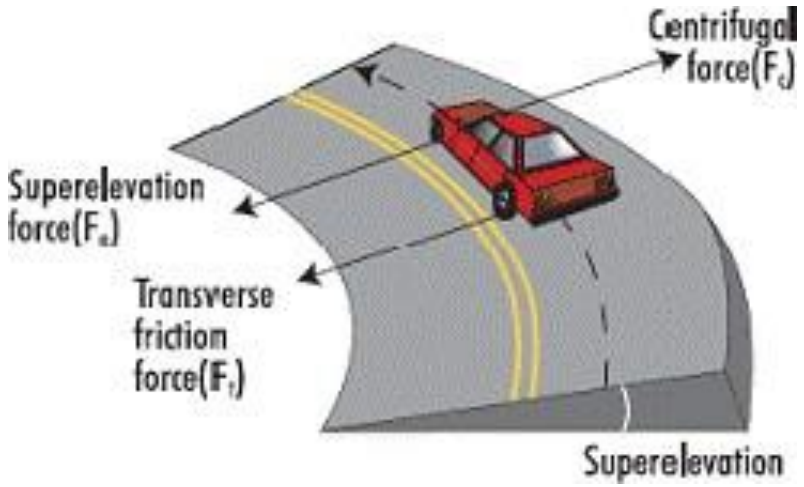
The minimum radius of a circular curve *R* for a vehicle traveling at V k/h can be determined by using with respect to overturning force and stabilizing force in curve , using the following equation:

Dynamic Characteristics of the Vehicle

$$R_c = \frac{V^2}{127(e+f)}$$

Where;
V=vehicle speed (km/hr),
Rc = radius of curve (m),
f = coefficient of sliding frication (0.11- 0.17),
e = Superelevation rate (the inclination of the roadway toward the center of the curve (0.04 – 0.12).





THANK YOU