ANTI-LOCK BRAKING SYSTEM

TATA SIERRA SUV – MATLAB SCRIPT

1. Command Window Input & Results:

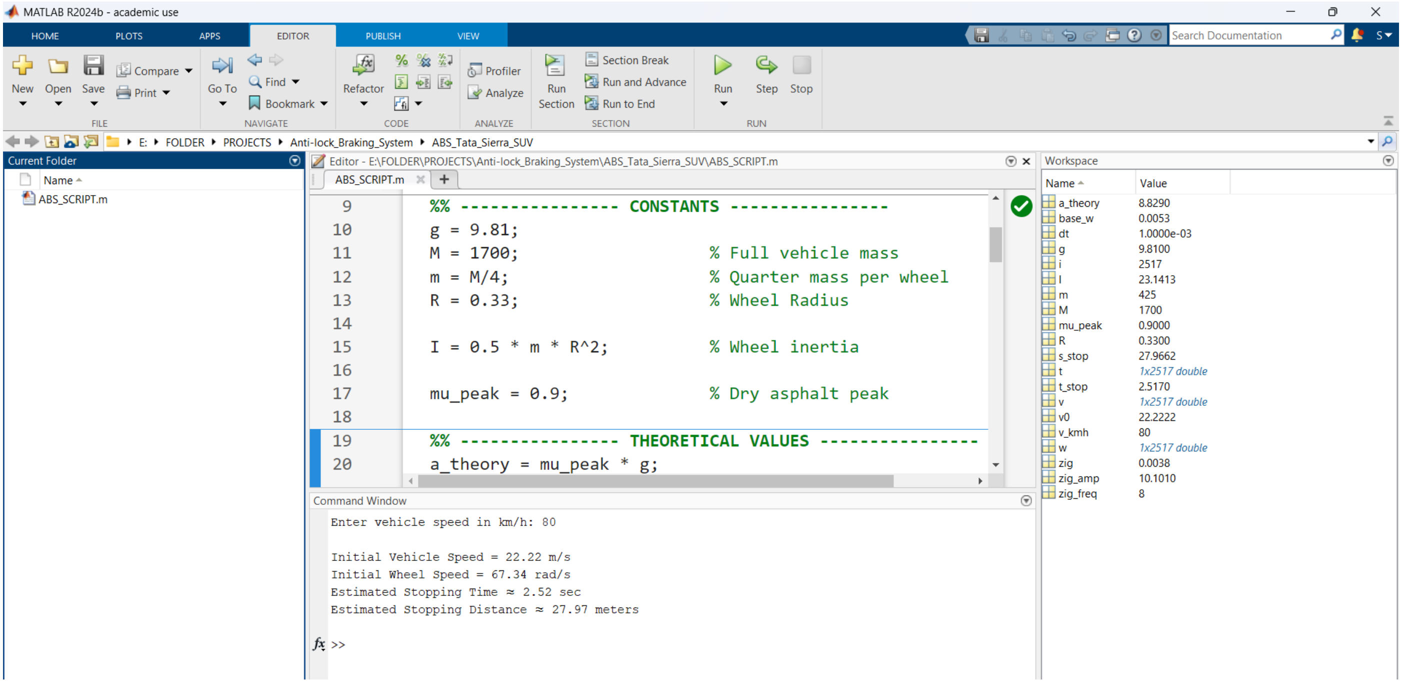

FIG.1.1: Displays user-entered vehicle speed and the computed theoretical values such as initial speeds, stopping time, and stopping distance using ABS braking equations.

2. WHEEL SPEED AND VEHICLE SPEED :

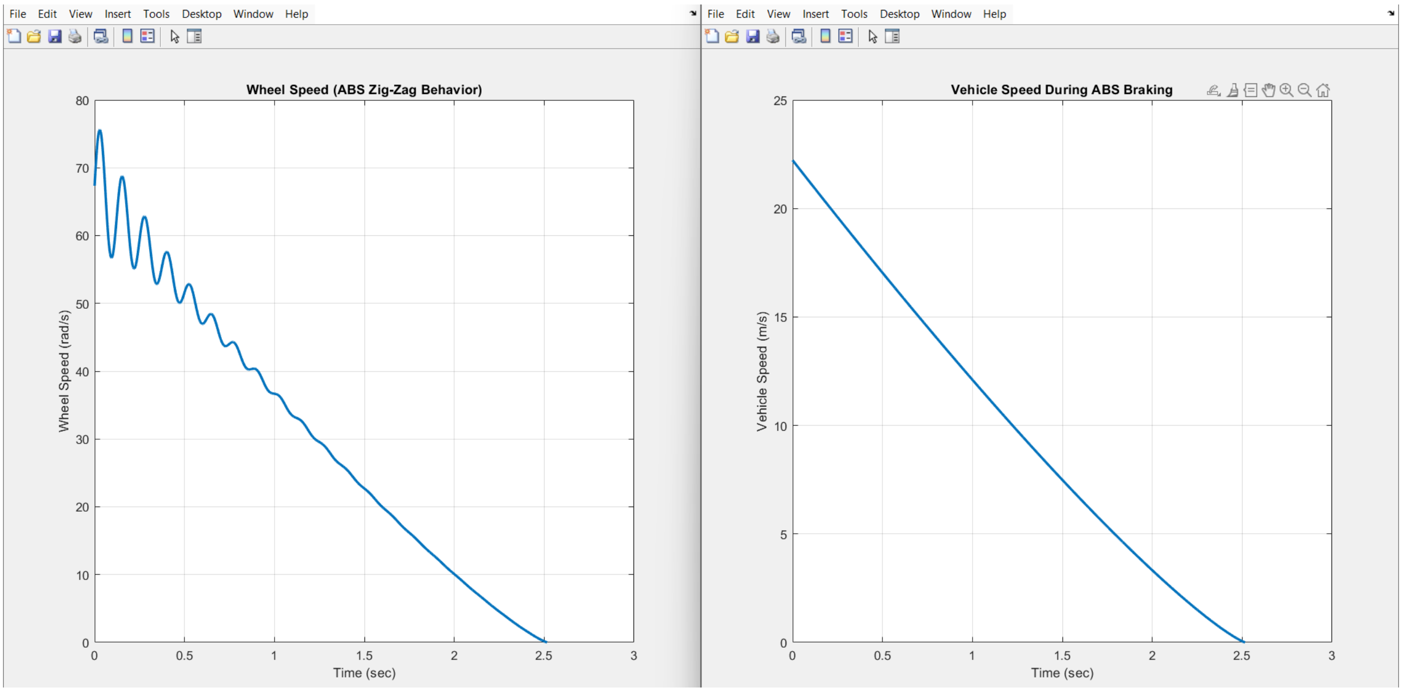

FIG1.2: WHEEL SPEED: Illustrates oscillatory wheel speed caused by ABS modulation, gradually decreasing to zero while preventing wheel lock.

VEHICLE SPEED: Represents smooth nonlinear reduction of vehicle speed from initial velocity to zero within the estimated stopping time.

Design And Calculations - ABS

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* STEP 1: Convert Vehicle Speed

$$V_o = \frac{80 \times 1000}{3600}$$

$$\boxed{V_o = 22.22\ m/s}$$

* STEP 2: Wheel Angular Speed

Given, $R = 0.33\ m$

$$\omega_o = \frac{V_o}{R} = \frac{22.22}{0.33}$$

$$\boxed{\omega_o = 67.34\ rad/s}$$

* STEP 3: Vehicle Mass Data

Total Vehicle Mass : $M = 1700\ kg$

$$m = \frac{1700}{4} = \boxed{425\ kg\ (\text{one wheel})}$$

* STEP 4: Normal Force on One Wheel

$$N = \frac{Mg}{4} = \frac{1700 \times 9.81}{4} = \boxed{4169.25\ N}$$

* **STEP 5:** Friction Force (Dry Asphalt)

For Dry road, $\mu \approx 0.9$

$F = \mu N$

$F = 0.9 \times 4169.25 = \boxed{3752.3\ N}$

* **STEP 6:** Vehicle Deceleration

$a = \frac{F_{total}}{M}$ (Total Force from 4 Wheel)

$F_{total} = 4F = 4 \times 3752.3$

$F_{total} = 15009.2\ N$

$\rightarrow a = \frac{F_{total}}{M} = \frac{15009.2}{1700}$

$\boxed{a = 8.83\ m/s^2}$

* **STEP 7:** Stopping Time

$t = \frac{V_0}{a} = \frac{22.22}{8.83}$

$\boxed{t = 2.52\ sec}$

* STEP 8: Stopping Distance

$$S = \frac{V_0^2}{2a} = \frac{(22.22)^2}{2 \times 8.83}$$

$$S = \frac{493.8}{17.66} = \boxed{27.97 \text{ meters}}$$

* STEP 9: Wheel Rotational Inertia

$$I = 0.5 \times m_{wheel} \times R^2$$

$$I = 0.5 \times 20 \times (0.33)^2 = 1.089 \ kg.m^2$$

→ $\boxed{I = 1.5 \ kg.m^2}$ is reasonable including tire + brake disc.

* STEP 10: ABS Theory

Slip ratio: $\lambda = \frac{V - \omega R}{V}$

ABS keeps slip near 0.15 - $\boxed{0.2}$

This produces:
* Zig-zag oscillation
* Average deceleration ≈ 8.8 m/s^2
* Stopping time ≈ 2.5 sec