Modelling an Anti-lock Braking System

ABS or an Anti-Lock Braking System is a piece of safety equipment that prevents the wheels of a vehicle from locking up under emergency, panic, or harsh braking conditions.

The wheel rotates with an initial angular speed that corresponds to the vehicle speed before the brakes are applied. We used separate integrators to compute wheel angular speed and vehicle speed. We use two speeds to calculate slip, which is determined by Equation 1. Note that we introduce vehicle speed expressed as an angular velocity (see below).

$$\omega_v = \frac{V}{R} \mbox{ (equals the wheel angular speed if there is no slip)}$$

**Equation 1**

$$ \omega_v = \frac{V_v}{R_r}$$

$$slip=1-\frac{\omega_w}{\omega_v}$$

$$\omega_v = \mbox{ vehicle speed divided by wheel radius}$$

$$ V_v = \mbox{ vehicle linear velocity}$$

$$ R_r = \mbox{ wheel radius}$$

$$ \omega_w = \mbox{ wheel angular velocity}$$

From these expressions, we see that slip is zero when wheel speed and vehicle speed are equal, and slip equals one when the wheel is locked. A desirable slip value is 0.2, which means that the number of wheel revolutions equals 0.8 times the number of revolutions under non-braking conditions with the same vehicle velocity. This maximizes the adhesion between the tire and road and minimizes the stopping distance with the available friction.