TIRE MODELLING FOR ANTI-LOCK BRAKING SYSTEM

D. MAHADEV BHATT (ME17AMTECH11011)
ARUN RONY (ME17AMTECH11007)
P. ABHIJITH (ME17AMTECH11002)
WHAT IS AN ABS?

- It is an electronic system which monitors and controls the skidding of the vehicle during braking action and prevents the wheels from locking.
- It was first developed in for the aircrafts in 1929.
- ABS allows the driver to maintain the steering control while braking and it shortens the braking distances on slippery surfaces.
- ABS is an additional monitoring and control function superimposed on the existing vehicle braking system.
- ABS has the ability to handle all the possible worst events in given time constraint.
BRAKING SYSTEM IN AUTOMOBILES

• Generally, the brakes are actuated by the hydraulic pressure.
• In a simple braking system, the applied force by the driver onto the brake pedal transmits to the wheel through an incompressible fluid.
• But, the brake force applied by the driver is difficult to stop transport vehicles carrying heavy loads.
• To apply the brake force multiple times, hydraulic systems are used.
• The hydraulic system contains cylinders fitted with oil and connected with oil filled pipe.
If the downward force is applied to one piston, then the force is transmitted to another piston in the pipe through the incompressible oil.

The Hydraulic system makes the force multiplication by changing the size of one cylinder and piston relative to the other one.
ABS ARCHITECTURE

- Electronic Control Unit
- Speed sensors
- Hydraulic control unit
- ABS control valves
- Control Algorithm

- Four channel ABS
- Three Channel ABS
ABS CONTD...

• Four channel ABS controls the brake force on each wheel individually.

• Three channel ABS controls the braking pressure on both the front wheels individually but rear wheels are controlled together, as a single unit.

• **Wheel Speed Sensors:** Constantly monitors the wheel performance and transmits the information to the ECU after particular interval of time.

• **ECU** receives the wheel performance data from each wheel sensor. When a wheel is about to lock, the ECU delivers a command to the hydraulic valve to control the brake pressure.
OPERATION OF ABS

• When the controller senses that the wheel is locking under the action of brakes, it first activates a solenoid valve to close the affected wheel’s brake line which prevents the pressure from increasing further.

• If the locked wheel continues to lose speed, the controller activates a second solenoid valve which removes the pressure off the affected brake line, in effect to release the brake for that wheel regardless of whether the driver is still pushing on the brake pedal.

• As soon as the wheel regains traction, the solenoid valves deactivate and normal braking system resumes.
Fig. 4. Anti-lock braking system.

Fig. 5. Free body diagram of a brake pedal.
\[ E_{k_0} = \frac{mv_0^2}{2} , \]

\[ Q_1 = \int_0^t (v_v - \omega R) \mu_0 mg dt , \]

\[ Q_2 = \int_0^t pS \mu_m \omega R dt , \]

\[ \lambda = \frac{v_v - \omega R}{v_v} \]

\[ \omega_0 + \int_0^t \left[ 2T/m_w R^2 \right] dt = \omega \]

\[ \text{RESULTANT MOMENT ON THE WHEELS} \]

\[ T = \begin{cases} R\mu_0 mg - pS\mu_m r (\omega > 0, v_v > 0) \\ R\mu_0 mg - pS\mu_m r (\omega = 0, v_v > 0, R\mu_0 mg > pS\mu_m r) \\ 0 (\omega = 0, v_v > 0, R\mu_0 mg \leq pS\mu_m r) \end{cases} \]

\[ \text{FLUID BRAKING MODEL} \]

\[ p_i + C_p \frac{dp_i}{dt} = p_z \]
SIMULINK MODEL
VARIATION OF SLIP WITH ABS
VARIATION OF SLIP WITHOUT ABS
VARIATION OF STOPPING DISTANCE
VARIATION OF WHEEL SPEED
VARIATION OF WHEEL AND VEHICLE SPEEDS WITH ABS
VARIATION OF WHEEL SPEED AND VEHICLE SPEED WITHOUT ABS
GRAPHICAL USER INTERFACE
GUI WITHOUT ABS
GUI WITH ABS
REFERENCES


THANK YOU